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Risk, Transaction Costs, and Geographic Distribution of Share Tenancy: A Case of Pre-War Japan

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Abstract

This paper investigates determinants of geographic distribution of share tenancy and analyzes its efficiency implications in pre-war Iwate prefecture, Japan. The distribution of share tenancy was attributable to risk represented by yield variability, which in turn was affected by seasonal winds called *Yamase* and topographic features. That risk raised transaction costs of adopting a fixed-rent tenancy associated with the common custom of rent reduction in Japan that mitigated the problem of risk-sharing. Estimation results suggest that risk, wealth, and strength of community ties were the main determinants of contract choice.

keywords tenancy, rent reduction, principal-agent model, moral hazard, transaction costs, Japan
JEL classifications D23; D82; O12; Q15
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1 Introduction

Given an acute insight provided by the theory of contracts, one of the two major strands of literature on agrarian farm tenancy contracts has specifically addressed risk-sharing and incentives as determinants of contract choice (e.g., Stiglitz (1974) and Holmstrom and Milgrom (1987). For a survey of the literature, see Singh (1989), Otsuka et al. (1992), and Huffman and Just (2004).), while the other strand addresses the transaction costs of enforcement, supervision, monitoring, and management of input and outputs (e.g., Cheung (1969), Alston et al. (1984), Eswaran and Kotwal (1985), Shaban (1987), Allen and Lueck (1995), and Chew (1998).) Even though each of these approaches provides a clear-cut insight and understanding of tenancy contract choice from one point of view, each may not be self-sufficient to portray a comprehensive picture of the complex reactions among numerous determinants.

We infer that risk-sharing and transaction costs were both important determinants of substantial regional difference in the geographic distribution of share tenancy in pre-war Japan's Iwate prefecture, where share tenancy was concentrated in the northeastern counties.[1] Why was there such clustering of share tenancy in specific counties?[2] Just as the risk-sharing models suggest, share tenancy was indeed associated with high risk as measured by rice-yield variability. However, further investigation into the causes of risk reveals the substantial influence of meteorological and topographic features. High yield variability in the share tenancy region resulted from cool-summer damage, which in turn was caused by seasonal winds called *Yamase* blowing from the Pacific Ocean. The regional difference in yield variability and contract distribution stems from the strength of the wind after buffering by the highlands before reaching the inland counties. Risk matters in this sense, but not only in the way that typical risk-sharing models suggest.

Risk affected the choice of contract by raising transaction costs of adopting a fixed-rent contract, given the common custom of rent reduction that associated fixed-rent tenancy in Japan. The custom required landowners to temporarily reduce fixed rents in the event of bad crops. Because this reduced risk burden by the tenant, there was little difference in terms of risk-sharing between share tenancy and fixed-rent tenancy, thereby allowing the landowner to adopt the

[1] Few studies have examined tenancy contracts in East Asia. See Barrett (1984) for the case of Taiwan and Jeon and Kim (2000) for Korea.

[2] Young and Burke (2001) study the relation between geographic patterns of tenancy contracts and customs.

latter system, which compels the tenant to work harder. Nevertheless, the custom of rent reduction raised costs in negotiating the execution and rate of reduction. The expected transaction costs were higher the more frequent the chance of bad crops. Therefore, rent reduction alleviates the trade-off between risk-sharing and incentives, but incurs a new trade-off between efficiency and transaction costs.

In addition to risk and transaction costs, community also played an important role in the contract choice because villages with strong communal ties were able to suppress transaction costs of rent reduction through communal governance of landowner-tenancy relationships. Community also contributed to enhancing the ability to assess the extent of production shocks within the village through crop yield sampling, which may mitigate the problem of moral hazard.

This study is intended to investigate determinants of the geographic distribution of share tenancy in pre-war Iwate prefecture comprehensively with respect to risk, meteorological and topographic conditions, transaction costs, communal ties, and industrial structure. We also attempt to test the Marshallian inefficiency—the potential low productivity under share tenancy caused by the inefficient supply of tenant's effort—because the tenant receives only a fraction of the marginal product of labor. For our study purpose and characteristics of the village-level data used herein, our econometric method is somewhat modest and some empirical results are not robust. We are unable to test the implications of risk-sharing or transaction costs models for individual contract choice with sophisticated econometric methods using farm level data as in the previous empirical studies. We attempt, with this study, to elucidate the forest rather than the trees and consider the geographic distribution of share tenancy from a broader point of view at the prefecture level.

Our results showed that, in general, risk was the major determinant of tenancy distribution in pre-war Iwate. Share tenancy was prevalent in high risk villages, either to mitigate risk from the tenant, or to reduce transaction costs of rent reduction associated with a fixed-rent contract. On the other hand, engagement in sericulture and employment opportunities in mining had a negative impact on the adoption of share tenancy, possibly because of its effect in stabilizing income, thereby supporting the prediction of risk-sharing models. We also found some correlation between the prevalence of share tenancy and low labor productivity in rice production. However, this inefficiency is not clear once we consider other crops, suggesting a possible moral hazard of shifting intensive work effort from rice production in paddies under share tenancy to subsidiary crops that were not subject to the payment of rent.

The remainder of the paper is organized as follows. The proceeding section summarizes a framework of tenancy contract choice with some accounts on rent reduction and its implications for contract choice. Section 3 presents a discussion of the historical background of a case of Iwate in pre-war Japan with descriptive data. Section 4 provides quantitative empirical results. Section 5 concludes this presentation.

2 Conceptual Framework

This section summarizes three key concepts—moral hazard and risk-sharing, transaction costs, and observability of production shocks—which we consider in the present study. Some discussions are formalized in the Appendix for clarity. Detailed descriptions of the case of pre-war Iwate are given in the subsequent section to allow sufficient explanation of rather general concepts.

2.1 Moral hazard and risk-sharing

Existing literature of tenancy contracts armed with the theory of contracts usually addresses two aspects: incentives and risk-sharing. The landowner (we regard landowners as female and tenants as male for expositional clarity) suffering for a moral hazard or a hidden action problem in which she cannot monitor or verify the tenant's action, intends to provide incentives to the tenant by offering a relatively fixed rent scheme—a scheme in which the rent is less dependent on actual output: ultimately, a fixed-rent tenancy. However, a fixed-rent contract imposes too much risk to the tenant because he is obligated to pay the fixed rent no matter what the actual output might be. As a result, the landowner must reduce the dependency of compensation on output, typically by offering a share tenancy or by lowering the level of fixed-rent to satisfy the tenant's participation constraint.[3] The essential message is that the landowner is facing the trade-off between the provision of incentives and efficient risk-sharing.

This theoretical model of risk-sharing proposes two predictions that are subject to empirical testing. First, because share tenancy cannot fully motivate the

[3]Theoretically, the landowner can mix these methods by offering a share tenancy with some fixed transfer. A fixed transfer may be in either direction between the landowner and the tenant. For example, it can take the form of an additional provision of labor by the tenant, or provision of fertilizer or meal by the landowner.

tenant to work, but reduces risk from the tenant, it is predicted to be adopted in those villages that face high risk and have tenants with greater risk-aversion. Theoretically, income and assets affect the tenant's risk aversion if the tenant's utility function exhibits decreasing absolute risk aversion. Practically, tenants are thought to be more risk averse if they have lower wealth because it is not so easy for them to absorb a temporary decline of income.[4] In this sense, having more opportunities of stable employment strengthens the tenant's tolerance of risk by improving access to stable income sources.[5] The second prediction concerns productivity; it is predicted that there should be a significant difference in productivity between the two contracts. Because incentives are reduced under a share tenancy, it is expected that holding other things equal, farms adopting a share tenancy are less productive than those adopting a fixed-rent tenancy. Numerous empirical studies have been conducted to test these predictions, mostly using data for developing countries in South and Southeast Asia.[6] On the one hand, results for risk-sharing seem to be mixed.[7] On the other hand, for productivity prediction, Otsuka et al. (1992) concludes as an empirical proposition that "significant inefficiency of share tenancy is not common in areas where both share and fixed-rent contracts are available options (p.2013)".

2.2 Rent reduction and risk sharing

To study tenancy contracts in pre-war Japan, one must consider the common custom of state-contingent rent reduction that accompanied the fixed-rent tenancy.[8] In contrast to the majority of Asian countries,[9] a predominant form of paddy tenancy in pre-war period Japan was a fixed-rent tenancy-in-kind, but the landowners were expected to temporarily reduce the fixed-rent in cases of crop failure. Therefore, given fixed-rent R, the actual rent r to be paid was

[4]See Binswanger (1981), Quizon et al. (1984), Rosenzweig and Binswanger (1993), and Pennings and Garcia (2001) for empirical studies on risk preferences.

[5]See Schultz (1940) for the experience in the pre-war U.S.—the number of share tenancies adopted in Iowa increased rapidly after the Great Depression.

[6]See Chiappori and Salanié (2003) for a broad survey on the test of contract theory.

[7]For example, Allen and Lueck (1999) rejects the risk-sharing implication, whereas Ackerberg and Botticini (2002) supports it after controlling for endogenous matching.

[8]See Waswo (1977, ch2) for some description on rent reduction in pre-war Japan and Arimoto (2005) for its economic implications. See Basu (1992) for a discussion of the relation between rent reduction, share tenancy, and limited liability.

[9]Otsuka et al. (1992) reports that the average percentage of share tenancy in tenanted land for Asian countries exceeds 80%.

determined according to the following rule:

$$r(R, \hat{y}, y) = \begin{cases} R & \text{if} \quad y \geq \hat{y} \\ R - \phi(y) & \text{if} \quad y < \hat{y} \end{cases}, \tag{1}$$

where y is output and $\hat{y}$ is the cut-off value of y that was used for the determination of crop failure. Function $\phi(\cdot)$ specifies the reduction rate that was typically $\phi(y) = \hat{y} - y$. The rent was reduced proportionally to the decline of output. Consequently, fixed-rent tenancy with rent reduction (rent reduction contract for short) can be considered as a combination of share tenancy for bad years and a fixed-rent contract for fair or good years.

The rationale of rent reduction can be explained along two lines: limited liability and risk-sharing. Because the rent, in most cases in Japan, was required to be paid in kind, there was limited liability. The upper bound of rent cannot exceed the actual output. Rent reduction can be interpreted as a custom to meet this ex post restriction. Another rationale is a natural extension of the risk-sharing model; rent reduction functions as a risk-sharing device by reducing risk from the tenant in the event of crop failure. In this sense, Arimoto (2005) showed that accompanying a rent reduction clause to a fixed-rent contract ex ante is always more beneficial to the landowner than a pure fixed-rent contract (because it reduces risk from the tenant); it is more efficient than a share contract under marginally risky crops or regions and for low to moderately risk averse tenants (because it provides incentives with a fixed rent scheme for fair states). Given that risk in bad years is mostly insured by the landowner through rent reduction, risk-sharing becomes less important in the choice between a share tenancy and a rent reduction contract.

2.3 Rent reduction and transaction costs

Despite its ex ante superiority in terms of incentives and risk-sharing, a rent reduction contract may not always be beneficial compared to a fixed-rent tenancy because the contract entails potential transaction costs for negotiating the execution and rate of reduction. This is because the landowner has no incentive to reduce the rent ex post and the contract was informal. In many cases in pre-war Iwate, tenancy contracts were hold orally: they were not written down formally. The process of rent reduction was dominated by moral codes, social norms, and customs; there were no explicit agreements between the landowner and the tenant on the definition of production shock or how to measure it. The rate of rent reduction was also indeterminate.[10] As a result, the danger of disputes arose with regard to execution and the rate of rent reduction. Indeed, in some cases, landowners frustrated by such burdensome negotiations revised the contract to a share tenancy. In sum, a rent reduction contract mitigates the trade-off between risk-sharing and incentives by reducing risk from the tenant, but it suffers from a new trade-off between incentives and transaction costs.

Therefore, transaction costs were a key consideration of the landowner in determining the contract to offer. What then are the determinants of the level of transaction costs? At least two existed: risk and community. First because negotiation of rent reduction takes place only in the case of crop shortfalls, the expected transaction costs of rent reduction is higher the more frequent the crop failure. Therefore, high risk increases the expected transaction costs and favors the adoption of share tenancy. Second, transaction costs were lower in villages with strong communal ties where community played a positive role in governing the landowner-tenancy relationships through intervention or by social norms. We will discuss the role of the community in depth later.

2.4 Observability and measurement of production shocks

Observability and measurement of production shocks also affect contract choice (discussions in this subsection are formalized in the Appendix). Consider the production function

$$y = e + \epsilon, \tag{2}$$

in which y is output, e is the effort exerted by the tenant, and ϵ represents a random production shock that is distributed normally with mean zero. Most previous studies have (implicitly) assumed that y is contractable, i.e., observable by the landowner and verifiable to the third party. However, an absentee landowner cannot observe and make the rent contingent on y, so she must offer a fixed-rent or a fixed-wage contract. This is exactly what happened with absentee landowners in pre-war Iwate. Residency of the landowner is clearly an important determinant of contract choice.

Now, assume that y is indeed contractable. Were e and ϵ observable? We regard that the landowners in pre-war Iwate were unable to monitor e directly [11], but were able to measure, to some extent, the level of a production shock

[10] Ministry of Agriculture and Forestry of Japan (1934).

[11] The impossibility of observing the tenants' behavior in our pre-war Japanese context comes from the fact that there are typically numerous tenants cultivating paddy fields scattered all over the village.

ϵ. There are at least two reasons that lead us to this inference. First, although some landowners had started to migrate into the cities and became absentee landowners, many of them remained in the same village as the tenants. Second, some villages conducted crop yield sampling to estimate the average yield over the village. Moreover, some landowners cultivated their own plot of paddies. Using this information on average yield within the village or yield obtained by the landowner herself, she may be able to estimate the tenants' efforts to some extent of accuracy if the production functions of respective tenants are similar, the soil conditions of each paddy are known, and ϵ is not significantly different within the village.[12]

The observability of ϵ affects contract choice in different ways depending on whether it is quantitative or qualitative. If observability implies a quantitative improvement in measurement accuracy of ϵ captured by the landowner's ability to reduce the variance of ϵ, then better observability implies a more fixed rent scheme: rent becomes more independent on output (see Appendix for a formal argument). On the other hand, if observability implies a qualitative ability in measuring ϵ, i.e., the landowner observes ϵ with perfect accuracy. Thereby, the mode of contract is completely changed: the ex post compensation will always be used to pay a fixed-wage. This is true because the assumption that ϵ (and y) is perfectly observable implies that e is also (implicitly) observable. Therefore, the landowner can discipline the tenant by preparing an appropriate punishment or reward depending on e. For example, presume that the landowner can determine her rent depending on ϵ and offer the following rent reduction contract:

$$r(R, \hat{\epsilon}; \epsilon) = \begin{cases} R & \text{if} \quad \epsilon \geq \hat{\epsilon} \\ R + \epsilon & \text{if} \quad \epsilon < \hat{\epsilon}, \end{cases} , \tag{3}$$

where $\hat{\epsilon}$ is the cut-off value of ϵ in which the landowner decides to grant a rent reduction. The difference between this contract and that in (1) is that the reduction of rent in the latter case can only be dependent on y, which includes the noise ϵ. As shown in the Appendix, the contract described in (3) will induce the first-best effort[13] because the tenant fully enjoys his marginal return from the exerted effort; he is compensated implicitly but directly on e. Therefore,

[12] The possibility of ascertaining production uncertainty and estimation of effort has not received much attention in the literature of tenancy contracts previously except, for example, Newberry (1975). We thank Keijiro Otsuka for indicating the importance of this point, at least in the Japanese context.

[13] An alternative contract that can induce the first-best effort under (im)perfect observability of e is the "dichotomous" contract as in Harris and Raviv (1979).

there is no rationale in restricting the landowner's insurance of risk only in the case of bad crops and she should fully insure ϵ in all states, which results in a fixed-wage contract.[14] The fixed-rent part of a rent reduction contract under qualitative observability is "irrational" for two reasons: the landowner is imposing an unnecessary risk upon the tenant and she is abandoning the rent. It is difficult, therefore, to rationalize the fixed-rent scheme for good years, for which the sole role is to provide incentives that are not necessary if ϵ is verifiable. Despite this irrationality, the Japanese rent reduction was upward-rigid; state-contingent adjustment of rent was conducted solely in the event of bad crops and there was generally no increase of rent in good years. Note however, that the above results require verifiability of ϵ. For quantitative observability, the landowner needs to verify a signal y' which is not equivalent to y because the noise is eliminated in some degree by the landowner's observation. However, even if imperfectly observed effort is not verifiable, the parties can still achieve the first-best effort by renegotiating the contracts (Hermalin and Katz, 1991).

In sum, a quantitative observability of ϵ and its verifiability favors a fixed-rent tenancy by raising the accuracy of detecting the tenant's effort. Qualitative observability of ϵ and its verifiability favors a fixed-wage contract by its implicit observation of e. The irrational result of share tenancy or fixed-rent tenancy under qualitative observabality depends on its verifiability or the opportunity to renegotiate. The remainder of this paper presents a specific examination of the possibility of a quantitatively observable and verifiable case.[15]

3 Historical Background and Data

We study the geographic distribution of share tenancy in pre-war Iwate prefecture in the Tohoku region of northeastern Japan.[16] There are two features of

[14]In fact, some landowners did impose a de facto fixed-wage contract by setting a fixed rent at an extremely high level that it was almost impossible for the tenant to pay. Under such a high fixed-rent, by granting an appropriate rent reduction, the landowner can exploit all the surplus less the fixed subsistence output remaining to the tenant: a fixed wage.

[15]The qualitative observability case will not be considered because, given the irrational result, we cannot rationalize the adoption of contracts other than a fixed-wage contract. Verification of ϵ was difficult, as suggested by the fact that a main source of dispute on rent reduction centered upon the decision of a "standard" yield in the current year, which was contingent on ϵ. Moreover, renegotiation after the exertion of effort, but before the realization of output, was not present.

[16]For studies of Japanese agricultural history written in English, see Dore (1959), Hayami and Yamada (1991), Kawagoe (1999), and Waswo (1977).

farm tenancy for this time and location. First, the pre-war period was a time in Japanese history when farm tenancy was pervasive. Tenanted paddies in Iwate accounted for 41% of total arable paddy area and more that 62% of farming households cultivated at least some plot under tenancy in 1929. Second, share tenancy was concentrated in Iwate. The predominant form of farm tenancy was a rent reduction contract (fixed-rent tenancy with rent reduction) in Japan at that time,[17], but the former *Nambu* territory that covered a part of the contemporary Aomori and Iwate prefecture was an exception where it was well known for the popularity of share tenancy.

The main data sources are a report *Tokushu Kosaku Kanko: Nago Seido, Kariwake Kosaku no Jitsujo (Special Tenancy Customs: Current Conditions of Nago system and Share Tenancy)* published in 1932 by the Iwate prefectural government[18] and *Iwate-ken Tokei Sho (Annual Statistics of Iwate Prefecture), 1929.* All variables used herein for empirical analysis are village level and are collected from the latter except for the percentage of share tenancy adopted in tenanted paddy taken from the former.

We partition 13 counties in Iwate prefecture into three regions—share tenancy, mixed, and fixed-rent region—according to the prevalence of share tenancy to capture topographical and socio-economic characteristics. Table 1 shows the percentage of share tenancy in tenanted paddies and farms and the degree of risk measured by coefficients of variation of rice yield at the county level.

Table 1 about here

The share tenancy region consists of Shimohei, Konohe, and Ninohe counties, where more than 90% of the tenanted paddies were cultivated under share tenancy; the mixed region consists of Iwate, Kesen, and Kamihei where about 10–60% were under share tenancy; the remaining seven counties form the fixed-rent region. Figure 1 shows the geographic distribution of share tenancy. Discussions of risk and topography are provided later in the section.

Figure 1 about here

Based on data collected from *Annual Statistics of Iwate Prefecture*, we constructed a village-level dataset of variables that indicate the status of tenancy,

[17]We can reasonably assume that share tenancy was not so common because it was independently surveyed in a category of "special tenancy customs" through a round of comprehensive tenancy customs surveys (*Kosaku Kanko Chosa*) conducted in 1885, 1912, 1921, and 1936

[18]Published in Iwate Prefecture (1932).

wealth, industrial structure in terms of employment and output, and topographical conditions. Summary statistics of the variables are provided in the Appendix. In the rest of this section, we intend to elucidate the socio-economic status of respective regions and discuss some findings using descriptive statistics with particular emphasis on the potential determinants of tenancy contract distribution.

3.1 Tenancy contract

Despite the popularity of share tenancy in Iwate, it was not observed equally in the prefecture; rather, it was concentrated in specific counties, as shown in Fig. 1. The percentage of share tenancy in tenanted land recorded in a report *Special Tenancy Customs* dated February 1930 reveals the prevalence of share tenancy in Iwate at the village level. Among 13 counties in the prefecture, village level tenancy contract data are available for only some villages of the six counties in the share tenancy region, mixed region, and Iwate county. Nevertheless, as indicated in Table 1, a document[19] published in 1935 reveals that the percentage of share tenancy in tenanted land aggregated at the county level was, at most, 5.1% for those seven counties.

It is likely that landowners adopting a share tenancy suffered from tenants' moral hazard. A report composed by the Teikoku Nokai (Imperial Agricultural Association)[20] pointed out that share tenancy reduced the tenant's incentives and triggered further moral hazard. The statement is exactly that of the Marshallian inefficiency:

> "Under share tenancy, output is allocated by fixed rate regardless of the yield, and even if the tenant exerts more effort and as a result increases the output, half of the increment will be taken by the landowner. Therefore, it reduces the tenant's effort to improve his output, resulting in dominance of low productivity and low rent revenue caused by primitive and extensive farming. (p.49, our translation.)"

This Marshallian inefficiency is pointed out in some other studies of share tenancy as 'the cost of share tenancy'[21]. Therefore, it should be regarded that

[19] Cited in *Iwate-ken Nochi Kaikaku Shi (History of Land Reform in Iwate Prefecture)* published in Iwate-ken Nochi Kaikaku Shi Hensan Iinkai (Compilation Committee of the History of Land Reform in Iwate Prefecture) (1954).

[20] Published in Teikoku Nokai (Imperial Agricultural Association) (1942).

[21] Ministry of Agriculture and Forestry of Japan (1926, 1934), and Iwate Prefecture (1932)

moral hazard was widely recognized as a disadvantage of share tenancy.

Despite the drawback in terms of incentives, there were at least two good reasons for the landowner to adopt a share tenancy: transaction costs and horse breeding. According to a report *Special Tenancy Customs* that provides detailed qualitative information from historical origins of share tenancy to people's attitude towards it, the main reason for the adoption of share tenancy was unstable output of crops that increased transaction costs of levying a fixed-rent, as we have described in section 2.3. The main concern was that, because of the fluctuation of actual output, it was impossible for a tenant to pay a fixed-rent every year. Therefore, the landowner and the tenant needed to negotiate rent reduction. Share tenancy was favored by both parties to save the costs of this negotiation.

Another reason mentioned in the report is that the landowner adopted a share tenancy to obtain straw for horse breeding: it was common to share output in sheaves under a share tenancy, while under a fixed-rent contract, the tenant paid with threshed rice. The reasoning is not so convincing because it is possible for the landowner to ask the tenant to providing straw under a fixed-rent tenancy as well. One justification is that a tenancy arrangement was made solely for rough rice and not sheaves and the landowner needed a special arrangement to claim for the delivery of straw in case of fixed-rent tenancy, whereas share tenancy was sometimes called *taba-wake* meaning "sharing sheaves". It is notable that Iwate prefecture was well known for horse breeding: the region enjoyed suitable natural conditions and mountainous topology (Mori, 2003). The prefectural government promoted horse breeding as a part of an agronomic improvement policy that encouraged intensive use of horses in tilling and to meet the rising demands for military horses for wars, such as those against China (1894–95) and Russia (1904–05).

Overall, it seems that costs of rent reduction caused by unstable output and linkage with horse breeding were the two major reasons for the adoption of share tenancy despite the wide recognition of moral hazard.

3.2 Risk and Yamase wind

The indicator of risk we employ is the coefficient of variation of rice yield over time. We collected 10 years (1923–32) of village level time-series rice-yield data from *Annual Statistics of Iwate Prefecture* to calculate it. This variable represents the risk of rice production, possibly because of bad weather, flood, drought, or damage caused by insects and disease. Rice yield variability was greater for villages in the share tenancy region than for those in mixed or fixed-rent regions.[22] The region average coefficient of variation of intertemporal rice yield for the villages in share tenancy, mixed, and fixed-rent regions are 0.24, 0.16, and 0.15, respectively.

One cause of this progressive difference in yield variability is the seasonal wind called *Yamase*: a cool moist air current originating in the Okhotsk Sea High that blasts the Pacific Ocean side of Tohoku region in early summer (Bokura, 1998). The Tohoku district is well known for frequent bad harvests and serious famines that plagued the district at least three times during the late Tokugawa period.[23] The source of bad harvests and high rice yield variability is cool summer damage.[24] Because Tohoku (literally meaning northeast) region ranges in the northern part of Japan, its temperature is lower than all other districts except for Hokkaido, and is likely to suffer from cold weather. A remarkable feature of cool summers in Tohoku region, however, is that there is an abrupt difference of damage between the Pacific side of the region and the Sea of Japan side. A key to understanding this distinction of damage is that the thickness of Yamase is only 1,000 to 1,500 meters high above the ocean. For that reason, the wind blowing from the Pacific side is blocked and weakened by the Ohu Mountains before reaching the Sea of Japan side. In the case of Iwate prefecture, the wind is blocked by the Kitakami Highland. This flow and blockage causes distinctively high rice yield variability in the villages of the share tenancy region along the Pacific Ocean.

3.3 Community

Community also played an important role on the choice of tenancy contracts through mitigation of transaction costs and measurement of production shocks. The two roles of communities in the mitigation of transaction costs were communal intervention to private landowner-tenancy relationships and collective tenancy. It was common for a community to intervene in private landowner-

[22]See the Table in the Appendix for figures.

[23]Iwate is also known for tsunami damage. For example, the highest tsunami ever recorded in Japan had a height of 38.2 meters. It struck Ayasato village of Kesen county in 1896, killing more than 22,000 people. In 1960, 61 people were killed in Iwate by a tsunami caused by an earthquake off the coast of Chile.

[24]*Yamase* not only harms agricultural products on shore – it also causes damage to fisheries. It is recorded that "*ama* (woman divers) moan that the sea 'breaks down' when Yamase blows. (Mori, 1982, p.886)"

tenancy relationships on yield sampling, collection of rents, rice inspection, and rent reduction. As described previously, villages conducted a village-wide crop yield sampling called *kemi* or *tsubogari* to estimate the average yield over the village. The sampling provided information to estimate the production shock in the village, which could have greatly suppressed the transaction cost of setting the "standard" yield used as a reference for rent reduction. These communal interventions were likely to have originated from the *Murauke* system enacted in the Tokugawa period, a village taxation system by which a village was jointly responsible for paying taxes. Under this joint-liability on paying taxes, a village intervened into various social activities including management of irrigation systems and community forests, politics, and ceremonial functions. In addition to this communal intervention, landowners and tenants were both restricted by social norms such as "not to exploit excessive rents", "not to withdraw tenanted land" for the landowner and "not to be late in payment of rents", "not to devastate tenanted land" for the tenant (Sakane, 2002).

It is worth emphasizing that our study period straddles an era of transition from informal communal governance of tenancy relationships to modern legal-based governance. After the gradual breakdown of informal communal governance caused by economic development after the turn of the century, a new governance system, which might be called a "collective tenancy," had started to form, led by the adoption of the Tenancy Conciliation Law in 1924 and raging tenancy disputes in the 1920s to late 1930s (Shoji, 1991). A collective tenancy consists of either a collective conclusion of a (formal) tenancy contract within the community or a governance of tenancy by the village agricultural committee. Thereafter, rent reduction was institutionalized and made more objective by requiring attendance of a third party such as the agricultural committee during its process.

We measure the strength of communal ties using three variables: number of resident households, fraction of households engaged in agriculture, and the paddy-field ratio. The number of resident households is intended to capture the idea that collective action is easier to organize in smaller groups (Olson, 1965; Bardhan, 2000). The fraction of households engaged in agriculture represents occupational homogeneity and agricultural concentration. It also reflects the idea that communal ties are generally stronger in an agriculture-oriented village for its nature for need of collective actions over the use and management of irrigation and commons, and the likeliness of "collective tenancy", which lowered transaction costs of rent reduction. Finally, the paddy-field ratio captures the idea that paddy farming required more collective actions of farmers than field farming, especially for water administration, which in turn, strengthened communal ties (Tamaki, 1983).pp.19–20.

Summary statistics reveal no substantial regional differences in the number of resident households; each village had approximately 600 households. However, marked differences are shown in the values of the other two variables. In the fixed-rent region, the fraction of households engaged in agriculture was, on average, 10% higher than in the other two regions. The paddy-field ratio also bespeaks a stark regional difference: 0.19, 0.51, and 1.47, respectively for share tenancy, mixed, and fixed-rent regions. These figures suggest that villages in the fixed-rent region have stronger communal ties than those in the other two regions.

3.4 Industrial structure

It is useful to observe the variables of industrial structure to capture the progress of industrialization and to infer opportunities of off-farm employment. Industrialization might affect both attitudes towards risk and communal ties by providing secure income sources to the tenant or by weakening communal ties through reduced benefits of local cooperation.

The *Annual Statistics* provide village level data of industrial structure both in terms of employment and output. Especially addressing the composition in terms of employment and output [25], we recognize three characteristics from these figures. First, the major industry in the fixed-rent region was agriculture in terms of both employment and output. On average, 78% of the labor force was engaged in agriculture (including livestock and forestry) and produced 85% of the total output. Second, the weight of the modern sector (industry and commerce) was not so different across regions, occupying around 10–15% of labor and output. Third, forestry and fisheries have a higher weight in share tenancy and mixed regions than in fixed-rent regions because of mixed regions' mountainous topography and coastal location.

Other important sectors that might have affected the tenancy contract choice were sericulture and silk-reeling. Japan was the largest exporter of raw silk in

[25] Sectors for employment are agriculture (including livestock and forestry), fishery, mining, industry, and commerce, whereas sectors for output are agriculture, livestock, forestry, fishery, mining, and modern sector (industry and commerce).

the world from 1909; raw silk was the leading export good at that time. The prefectural government of Iwate encouraged sericulture as a village promotion policies after the crop failure in 1905 (Nakabayashi, 2003). Encouragement by the government consisted of production of standardized cocoon suitable for modern silk-reeling, promotion of double-cropping in spring and summer, and establishment of cocoon-drying facilities. On average, approximately half of the households in Iwate engaged in raising silkworms, producing 57.4 yen output per household, occupying 7.9% of the total output and 13.8% of the agricultural output. However, the momentum of sericulture in terms of cocoon output peaked in 1932 because of the sharp decline of prices caused by the Great Depression, which started in 1929.

4 Empirical Results

4.1 Estimation of geographic distribution of share tenancy

In this section, we quantitatively investigate the correlation between the geographic distribution of share tenancy measured by percentage of share tenancy in tenanted paddies and its potential determinants: risk, wealth, and community. The main theoretical predictions that we test are summarized as the following. Table 2 shows the direction of respective determinants to the prevalence of share tenancy.

P1 (risk) Share tenancy is chosen in villages that face a high risk of yield variability.

P2a (wealth) Share tenancy is chosen in villages where the tenants have low wealth (as predicted by the risk-sharing model).

P2b (wealth) Wealth has a neutral effect on contract choice (as predicted by the transaction cost model).

P3 (community) Share tenancy is chosen in villages where communal ties are weak.

Table 2 about here

For clarity, we will refer to the negative correlation between wealth and share tenancy as a "wealth effect" on contract choice. That is, holding more assets or having access to stable income sources renders the tenant more tolerant to risk and allows the landowner to adopt a fixed-rent contract. A negative correlation between the strength of communal ties and share tenancy is referred to as a "community effect". That is, villages with strong communal ties are able to reduce transactions and can adopt a rent reduction contract. "Wealth effect" and "community effect" are considered to affect contract choice only through either of the risk-sharing or transaction models. Thereby, we can identify whether risk and transaction mattered. Note however that positive correlation between risk and share tenancy is predicted by both models. For that reason, even if we find positive and significant correlation between risk and prevalence of share tenancy, it is not easy to identify the path of that causality.

For testing the predictions, we use the following reduced-form specification:

$$s_i = \beta_0 + \beta_1 r_i + w_i \beta_2 + c_i \beta_3 + u_i, \tag{4}$$

where s_i, r_i, w_i, and c_i respectively denote the intensity of share tenancy, risk, vector of wealth variables, and vector of community variables in village i. For wealth variables, we included (i) total area of cultivated land (paddy and field) to measure the stock of wealth, (ii) total output from all sectors per household to measure the flow of wealth, and (iii) the fraction of income from the modern sector (mining, industry, and commerce) to control for the stability of the income stream. For community variables, we use (i) the number of resident households, (ii) the fraction of households engaged in agriculture, and (iii) the paddy-field ratio, for the reasons stated in section 3.3.

Before moving on to the results, two remarks on the dependent variable are in order. First, the variable is censored, ranging between 0 and 100.[26] Therefore, we employ the Two-Limit Tobit model. Second, our dependent variable is truncated: we do not have village level data of the dependent variable for all 111 villages in seven counties in the fixed-rent region and 31 villages in five counties in the share tenancy and mixed regions. For villages that lack a dependent variable to handle this issue, we substitute the county average. We exclude the 15 villages in Shiwa county because that county average is not available.

4.2 Results on geographic distribution of share tenancy

The result of the Two-limit Tobit estimates of geographic tenancy contract distribution are reported in Table 3. A positive coefficient indicates that an

[26] Out of 95 villages in six counties for which we were able to collect village level data of dependent variable, 47 are right-censored; every tenanted paddy is cultivated under a share tenancy. One is left-censored.

increase in the level of explanatory variables increases the percentage of share tenancy adopted in tenanted paddies.

Table 3 about here

Estimates for risk are positive and show a high magnitude of statistical significance in every specification conducted, suggesting that risk was indeed a major determinant of contract choice. Coefficients of assets (cultivating area per household) are negative and significant for some specifications. However, the result is not robust to the inclusion of community variables. We suspect potential multicollinearity between employment in agriculture, which could have reduced the significance of the coefficients. Coefficients for income (output per household) are consistently not significant in all specifications. Compared with the result for assets, this suggests that the stock of wealth had greater impact on the risk attitude than the flow of income. We have also included a variable that represents the stability of the income stream (fraction of output from modern sector), which is negative and significant, after inclusion of all wealth and community variables in (5). Column (6) uses employment stability instead of output and the coefficient is still negative and significant. Together with results for income, these results imply the importance of stability rather than the total value of output within a village.

For community variables, coefficients for occupational homogeneity (fraction of households engaged in agriculture) and the paddy-field ratio are negative and significant. These signs of coefficients imply that villages with potentially strong communal ties are likely to suppress transaction costs on rent reduction and reduce the adoption of share tenancy, supporting the presence of a community effect. Coefficients for the number of resident households are negative but not significant, so the group size had little effect on the control of transaction costs.

Finally, because we have replaced the county average of the dependent variable for samples that lack village level data, column (7) shows Probit estimates for a dummy dependent variable to investigate the possibility of measurement error: 1 if the percentage of share tenancy is more than 50% and 0 otherwise. The wealth variables are now not significant but risk and community variables continue to show significance in the right direction. Column (8) shows estimates using only villages with share tenancy data. Some variables, such as output from the modern sector and employment in agriculture, lost their statistical significance after limitation of data. Most eliminated villages are contained in the fixed-rent region. Therefore, this estimation is vulnerable to sample selection bias. A concessional interpretation of the estimation using limited samples would be that we are investigating the cause that alters the prevalence of share tenancy in a village given that the village adopted share tenancy. Despite this problem of sample selection bias, the estimate illustrates that risk and the paddy-field ratio are immune to limitation of data.

We can summarize that the mechanisms of both risk-sharing and transaction costs models seem function in determining the geographic distribution of share tenancy in Iwate. These estimation results support the presence of both wealth effect and community effect as components of models of risk-sharing and transaction costs. It is likely that share tenancy was adopted in risky villages to share risk and in villages with more asset or access to stable income sources. On the other hand, rent reduction contracts were likely to be adopted in villages with stronger communal ties, arguably because of low transaction costs.

4.3 Share tenancy and industrialization

Does share tenancy tend to decline with advanced industrialization? If so, development of which industrial sector would be prominent in such a change? To investigate the correlation between contract choice and industrialization, variables that represent the development of non-agricultural industrial sectors in terms of employment and output are added: employment composition, output composition, and output per household. Variables that capture the intensity of sericulture are also included separately because their impact on household income is not negligible. We note that the direction of the effects of non-agricultural industrial sectors is an empirical question. Development of a certain sector may provide stable income to the tenant and enhance wealth effect. However, there is no reason to ignore the possibility that such development may weaken communal ties – a negative community effect – because better urban connections may reduce the benefit of fostering local cooperation. Therefore, it is not easy to determine which effect prevails in a certain sector a priori, and we do not attempt to make predictions of the sign of each sector.

Table 4 about here

Results of Two-limit Tobit estimates with additional variables are shown in Table 4. Columns (2) and (4) use output composition whereas (3) and (5) use output (yen) per household. We continue to control for wealth and community ties with the same set of variables as in Table 3. Coefficients of risk and paddy-field ratio continue to be significant and have the appropriate sign, but variables of wealth and community are not robust to inclusion of additional industrial variables.

The overall picture suggested from this estimation is that "primary industry villages" with higher weight on non-agricultural primary industries such as livestock, forestry and fisheries are likely to have more share tenancy, whereas villages with higher weight on mining or sericulture are likely to have less. According to our conceptual framework, negative coefficients indicate the wealth effect. Coefficients for employment in mining and sericulture show such a trend, which is understandable because these sectors are likely to offer relatively regular and stable employment and income opportunities. On the other hand, coefficients for output of livestock, forestry, and fisheries are positive and significant in some specifications. A positive correlation between output composition of livestock and share tenancy confirms the connection between horse breeding and share tenancy. Are others exhibiting the negative community effect implying a weakening of communal ties? We regard both the community effect and wealth effects because income generated from these sectors of primary industries are likely to be unstable.

A square term of output per household from sericulture is included to control for its potential instability of sales; the raw silk price, and accordingly, the cocoon price fluctuated greatly.[27] Signs of the coefficients for output per household from sericulture are uniformly positive and mostly significant, in contrast to that for employment, if the square term is not included (not shown). We infer that this is true because of the riskiness of sericulture. Respective variations of raw silk and cocoon prices were 0.103 and 0.109 in the 1900s, 0.359 and 0.412 in the 1910s, 0.153 and 0.172 in the 1920s, and 0.277 and 0.342 in the 1930s (Fujino et al., 1979). Consequently, too much reliance on sericulture exposes the tenant to risk and would induce a favorable view towards share tenancy to reduce risk from rice production. Results in Table 4 confirm this inference that the coefficients were not significant following the inclusion of a square term.

[27] The average raw silk price in Yokohama was 35.467 Yen/kg in 1919, 29.717 in 1924, 21.834 in 1929, 8.950 in 1934, and 22.967 in 1939. The estimated cocoon price was 2.63 Yen/kg in 1919, 2.15 in 1924, 1.67 in 1929, 0.86 in 1934, and 2.24 in 1939.

4.4 Estimation of agricultural productivity

The presence of productive inefficiency resulting from share tenancy has been a salient point of debate in the literature. In this subsection, we attempt to test the negative correlation between the intensity of share tenancy and agricultural productivity. Low productivity in share tenancy villages prevails, if at all, because the supply of tenant's effort is less than the first-best case because the tenant receives only a fraction of the marginal product of labor after controlling for production conditions, as Marshallian theory asserts.

To empirically assess this Marshallian inefficiency on productivity the effects, we utilize the following basic formulation:

$$y_i = \beta_0 + c_i\beta_1 + t_i\beta_2 + x_i\beta_3 + u_i, \tag{5}$$

in which y_i, c_i, t_i, and x_i respectively represent agricultural productivity, vectors of tenancy contract (percentage of share tenancy), the tenancy rate, and control variables. We utilize labor productivity as a measure of agricultural productivity with respect to the harvest yield of rice measured in *koku* and overall output from the agricultural sector measured in yen, i.e., sum of the sales of all agricultural products. They are normalized by the number of cultivating workers estimated by multiplying the average household size by the number of cultivating households. Our primary interest is the sign and significance of the coefficient of the percentage of share tenancy (β_1), which the Marshallian theory predicts as negative. The sign of the tenancy rate (β_2) is also of interest because it captures the effect of property rights on efficiency through investment and land improvement.[28] We include the tenancy ratio in terms of labor (ratio of tenant household to cultivating household) and area (ratio of tenanted area in paddy and field) to represent the tenancy rate. The coefficients are expected to have negative correlation with productivity.

Two caveats must be given. First, we have no data regarding land quality and current inputs such as fertilizers and pesticides. We attempt to partially resolve this problem of omitted variables by adding per-household output from the livestock sector, which produces manure. Second, because we normalize the output by estimating the number of cultivating workers, the output reflects neither the precise number of workers nor the effective hours of farming. We include the fraction of full-time farmers to all farmers to mitigate this problem. If these variables are poor proxies for current inputs, then the estimates could

[28] Banerjee et al. (2002), and Besley (1995).

be biased. Therefore, the estimation results in the following subsection should be viewed critically.

4.5 Results on agricultural productivity

The results of OLS estimates of productivity are presented in Table 5. Columns (1) to (4) use labor productivity in terms of rice production and columns (5) to (8) use labor productivity in terms of total agricultural output.

Table 5 about here

Columns (1) and (2) treat contract choice as exogenous. We used the observed data of the percentage of share tenancy. Marshallian inefficiency is detected, as shown by negative and significant coefficients for share tenancy. The result is robust to the inclusion of risk in (2). To test for potential endogeneity between contract choice and productivity, (3) and (4) show the estimate of 2SLS by regressing the percentage of share tenancy in the first stage with explanatory variables used in column (5) in Table 3.[29] The result does not change substantially, suggesting that potential endogeneity, if any, may not be great. A similar exercise was conducted with labor productivity in terms of total agricultural output in (5) to (8). Contrary to the labor productivity of rice production, coefficients for the percentage of share tenancy for total agricultural productivity are not significant, signs are mixed, and the estimate is sensitive to the inclusion of risk.

For the variables of tenancy rate, coefficients are all significant whereas the sign shows a clear contrast between paddy and field: coefficients for paddy tenancy rates are positive, whereas those for farm tenancy rates are negative. These signs of coefficients imply that the high tenancy rate of paddy improves productivity whereas the high tenancy rate of field harms it. The difference of the signs might be explained partly by the different durations of tenancy relations for paddy and field tenancy: paddy tenancy is typically longer, so tenants have more incentive to invest in their tenanted paddy and to improve land productivity. Note however, that this does not explain the correlation between high productivity and a high paddy tenancy rate. One way to account for this correlations is that competition exists between the tenants to rent paddies, which raises tenancy rates and productivity because tenants would work hard to

[29] Even though the independent variable (percentage of share tenancy) in the first stage is censored between 0 and 100, the usual procedure of 2SLS is valid. See Angrist and Krueger (2001).

maintain tenancy relations. It is also interesting that positive correlation exists between cultivating area and productivity, suggesting economies of scale.

As the results show, Marshallian inefficiency is reflected in rice production, but not after the inclusion of other agricultural production. This result may result from a possible shift of intensive work effort from paddy production to other crops; tenants under share tenancy in paddies tend to shirk on rice production and instead work intensively in other crops. Such moral hazard might occur because tenants were free to grow subsidiary crops after rice production in paddies; in addition, the field is likely to be leased out under a fixed-rent cash contract than paddy.[30] The possibility of the moral hazard is somewhat confirmed in (9) and (10) where the rate of engagement in sericulture is included. Estimates reveal that engagement in sericulture lowers rice productivity, while raising total agricultural productivity.

We summarize these results as follows: inefficiency in rice production might be caused by tenancy contracts and tenancy rates. Nevertheless, there is no sign of inefficiency if we examine the overall productivity of agriculture, which suggests a possible shift of the tenants' work intensity from paddies under share tenancy to other crops. As described earlier in the section, the proxies for current inputs may not be appropriate and the estimates could be biased by various factors. However, it should be emphasized that comparison of the estimation results between the two dependent variables provides some information for our analysis because there is no reason to think that current inputs affect only rice productivity and not total agricultural productivity, or vice versa. In this regard, the possibility of moral hazard in alternative crops should not be neglected.

5 Concluding Remarks

Through this study, we intended to contribute to the literature of agrarian tenancy contracts and landowner-tenancy relationships with new evidence from pre-war Japan by comprehensively considering the effects of transaction costs as well as risk and incentives.

Using detailed qualitative descriptions of tenancy relations documented in various reports, we have argued that both risk and transaction costs are possi-

[30] This kind of moral hazard was also recognized by feudal lords in Tokugawa period. A proclamation banned farmers from working intensively in weat production after poorly cultivating rice, which was subject to taxation (Fukaya, 1993, p.49).

bly important determinants of the contract choice. Given the common custom of rent reduction that accompanied a fixed-rent tenancy, transaction costs on negotiating the execution and rate of rent reduction were indeed a concern of landowners. The level of such transaction costs was dependent on the strength of communal ties that provided informal governance of tenancy relationships. Therefore, risk, wealth, and communal ties are considered as potential determinants of tenancy contract choice, where risk is predicted to favor share tenancy by both models, whereas wealth and communal ties have different effects on the choice of contracts depending on the model considered.

Quantitative results of the distribution of share tenancy using village level data reveal that risk was indeed a major determinant, either because share tenancy mitigates risk from the tenants or because it saves transaction costs of rent reduction. Access to stable income sources and strong communal ties, on the other hand, enabled the adoption of rent reduction contracts, possibly by strengthening the tenants' tolerance to risk and by suppressing transaction costs. We also found that share tenancy was adopted in villages with higher weights on non-agricultural primary industries. Existence of productive inefficiency caused by share tenancy has been a salient point of debate in the literature. Our estimation results do indicate a sign of Marshallian inefficiency on rice production, but not after considering for other crops. However this result could be biased as a result of the poor proxy of current inputs and should be taken with caution. We also emphasize the possibility of moral hazard that the tenants allocated their intensive work effort from paddies under share tenancy to other crops.

It is likely that in rural areas of pre-war Japan, the way of being of the rural community played an important role in the choice and efficiency of tenancy contracts before penetration of the modern legal system. The role of the community in governance of tenancy relations, however, has not been studied in detail and is left for future research. It is worth emphasizing that the choice of tenancy contracts is indeed a result of complex reactions among many determinants. We propose to investigate as deeply and comprehensively as possible the socio-economic contexts before applying simple theoretical models into the study of tenancy contracts.

Appendix A Simple Principal-Agent Models

This appendix presents some simple principal-agent models following Holmstrom and Milgrom (1987) to confirm and formalize the ideas and implications of some models asserted in section 2.

A.1 A risk-sharing model[31]

Output y is produced according to a production function, $f(e) = e + \epsilon$, in which e represents the effort exerted by the tenant with cost $c(e) = ke^2/2$ and $\epsilon \sim N(0, \sigma^2)$ is a random production shock. As in standard models of moral hazard, y is verifiable, but not e (we relax this later). We are restricted to a linear compensation scheme for the tenant: $w(y) = \alpha y + \beta$. A fixed-rent contract is expressed by a combination $\alpha = 1$, $\beta < 0$, whereas a share tenancy is expressed by $1 > \alpha > 0$ (typically $\alpha = 1/2$) with a "pure" share tenancy of $\beta = 0$. The landowner is risk-neutral and the tenant is risk-averse, whose utility function exhibits constant absolute risk aversion (CARA):

$$u(w(y) - c(e)) = -\exp\{-r(w(y) - c(e))\}. \tag{A.1}$$

The payoff (expected utility) of the landowner is $E[y - (\alpha e + \beta)] = e - \alpha e - \beta$ and the tenant's certainty equivalent income is $\alpha e + \beta - c(e) - \frac{1}{2} r\alpha^2\sigma^2$.[32]

The landowner's problem is the following.

$$\max_{e,\alpha,\beta} \quad (1-\alpha)e - \beta \tag{A.2}$$

$$\text{subject to} \quad \alpha e + \beta - \frac{1}{2} r\alpha^2\sigma^2 - c(e) \geq 0 \tag{PC}$$

$$e = \arg\max_{e'} \; \alpha e' + \beta - \frac{1}{2} r\alpha^2\sigma^2 - c(e') \tag{IC}$$

Therein, (PC) and (IC) are the tenant's participation constraint and incentive compatibility constraint (IC), respectively. Because β does not affect the tenant's choice on e, the landowner can always choose β^* to bind (PC): $\beta^* = c(e) + \frac{1}{2} r\alpha^2\sigma^2 - \alpha e$. Therefore, the reduced problem is:

$$\max_{e,\alpha} \; (1-\alpha)e - \beta^* \qquad \text{subject to} \quad \alpha - ke = 0,$$

and the solutions are:

$$e^* = \frac{1}{k(1 + kr\sigma^2)}, \tag{A.3}$$

$$\alpha^* = \frac{1}{1 + kr\sigma^2}, \tag{A.4}$$

$$\beta^* = c(e^*) + \frac{1}{2} r(\alpha^*)^2\sigma^2 - \alpha^* e^*, \tag{A.5}$$

and the landowner's payoff is

$$V_s^* \equiv \frac{1}{2k(1 + kr\sigma^2)}. \tag{A.6}$$

Plainly, the effort falls apart from the first-best effort $e^{fb} = 1/k$ and $\alpha^* < 1$ if $r\sigma^2 > 0$. The following proposition summarizes the well-known results.

PROPOSITION 1. *If the tenant is risk averse and there is uncertainty in production:*

(i) There will be inefficiency in the level of effort exerted by the tenant.

(ii) The magnitude of inefficiency is increasing in the tenant's risk aversion and production risk.

(iii) It is optimal for the landowner to offer a share contract.

[31] Simplification of the model in this subsection follows Itoh (2003).

[32] See, for example, Laffont and Martimort (2002, p.383).

A.2 Measurement of production shocks

This subsection presents investigation of the implication of the landowner's ability to measure production shocks.

The extent of production uncertainty, namely σ^2 can be reinterpreted as the landowner's ability to observe and verify the tenant's action. We have so far assumed that the landowner cannot measure the extent of ϵ and simply takes σ^2 as given. However, if the landowner can measure ϵ, then she can use this information in her contract. Denote the landowner's ability to measure ϵ or e by $m \in [0, \overline{m}]$. Given m, she can base her contract on a verifiable signal $y' = e + \epsilon'$ where $\epsilon' \sim N(0, \tilde{\sigma}^2(m))$, $\tilde{\sigma}^2(0) = \sigma^2$, $\lim_{m \to \overline{m}} \tilde{\sigma}^2(m) = 0$, and $d\tilde{\sigma}^2/dm < 0$. Thus, if the landowner has outstanding measurement ability, then y' would ultimately be equivalent to e. Under this interpretation of σ^2, equations (A.3) and (A.4) stipulate that the landowner can offer a more fixed contract and induce higher effort if she has high ability of measurement.

Proposition 2. *If the landowner has high ability to measure ϵ, then*

(i) She should offer a more fixed contract.

(ii) She can induce higher effort.

Next, we consider the case in which ϵ is verifiable under a rent reduction contract. To keep the contract as simple as possible, assume that the landowner proposes a rent reduction contract where the tenant's compensation is

$$w(y, R, \hat{\epsilon}; \epsilon) = \begin{cases} y - R & \text{if} \quad \epsilon \geq \hat{\epsilon} \\ y - (R + \epsilon) & \text{if} \quad \epsilon < \hat{\epsilon} \end{cases}, \tag{A.7}$$

where $\hat{\epsilon}$ is the cut-off value of ϵ in which the landowner decides to grant a rent reduction. Under this contract, the tenant earns a fixed share $y-(R+\epsilon) = e-R$ if $\epsilon \geq \hat{\epsilon}$ and risk is fully insured. The tenant's payoff (expected utility) is given by

$$\begin{aligned} U(e; \epsilon, R) &= \int_{\underline{\epsilon}}^{\hat{\epsilon}} u(y - (R + \epsilon)) f(\epsilon) d\epsilon + \int_{\hat{\epsilon}}^{\overline{\epsilon}} u(y - R) f(\epsilon) d\epsilon - c(e) \\ &= F(\hat{\epsilon}) u(e - R) + \int_{\hat{\epsilon}}^{\overline{\epsilon}} u(e + \epsilon - R) f(\epsilon) d\epsilon - c(e). \end{aligned}$$

It is straightforward to show that this contract induces the first-best effort $e^{fb} = 1/k$ by deriving the tenant's first-order condition with respect to e. Note that his earnings $e - R$ in the rent-reducing state is not a fixed-wage, but it is dependent on his effort e. For this reason, a rent reduction provides full incentives.

Proposition 3. *A rent reduction contract that compensates the tenant according to $w(y, R, \hat{\epsilon}; \epsilon)$ induces the first-best effort.*

Assuming the exponential CARA form utility function of the tenant and $c(e) = ke^2/2$, we have $e^* = 1/k$. The tenant's payoff can be rewritten as

$$U = e - R - \int_{\hat{\epsilon}}^{\overline{\epsilon}} \frac{1}{2} r\sigma^2 f(\epsilon) d\epsilon - c(e)$$

The optimal fixed-rent R is set to satisfy $U(e; \epsilon, R^*) = 0$:

$$R^* = \frac{1}{2k} - \int_{\hat{\epsilon}}^{\overline{\epsilon}} \frac{1}{2} r\sigma^2 f(\epsilon) d\epsilon.$$

The landowner's payoff under a rent reduction contract is

$$\begin{aligned} V_r &\equiv \frac{1}{2k} - \int_{\hat{\epsilon}}^{\overline{\epsilon}} \frac{1}{2} r\sigma^2 f(\epsilon) d\epsilon + \int_{\underline{\epsilon}}^{\hat{\epsilon}} \epsilon f(\epsilon) d\epsilon \\ &= \frac{1}{2k} - \frac{1}{2} r\sigma^2 + \int_{\underline{\epsilon}}^{\hat{\epsilon}} \left(\epsilon + \frac{1}{2} r\sigma^2 \right) f(\epsilon) d\epsilon. \end{aligned} \tag{A.8}$$

Because the second term is monotonically increasing in ϵ, she should set $\hat{\epsilon} = \overline{\epsilon}$. Thus we have:

PROPOSITION 4. *It is never beneficial for the landowner to leave a fixed-rent scheme in the contract.*

Appendix B Summary Statistics

Table 6 about here

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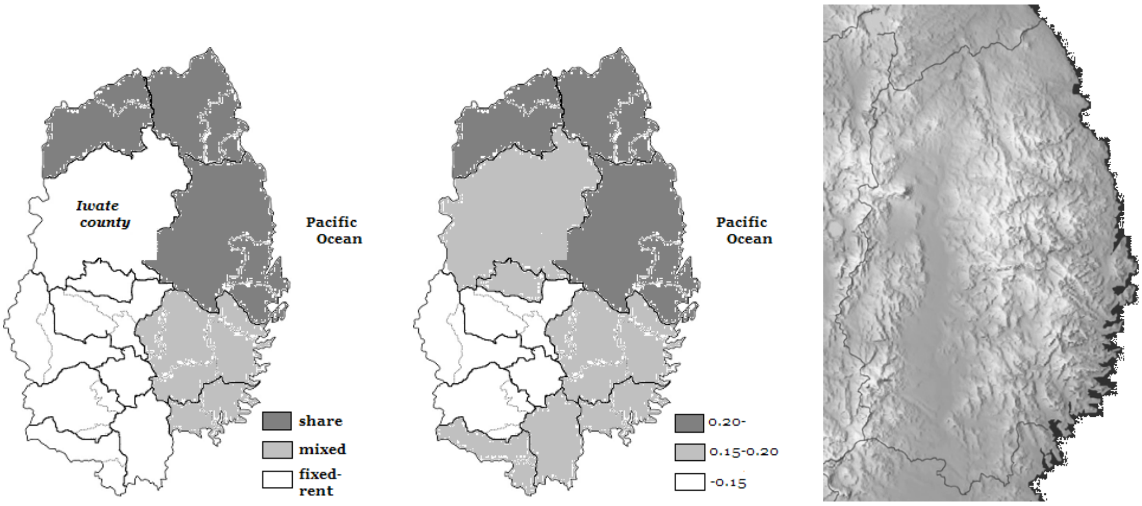

Figure 1: Tenancy contract distribution, risk, and terrain of Iwate

Table 1: Percentage of share tenancy

		Percentage of share tenancy		CV of yield	Samples	
					total	with tenancy
Region	County	paddy	field			data
share tenancy	Shimohei	99.8	98.7	0.21	27	17
	Konohe	99.4	98.0	0.31	20	18
	Ninohe	92.5	94.3	0.22	15	15
mixed	Kamihei	57.7	91.9	0.17	17	16
	Kesen	51.9	56.1	0.15	22	16
fixed-rent	Iwate	9.5	10.7	0.19	24	13
	Higashiiwai	5.1	13.5	0.15	23	0
	Waga	2.9	6.3	0.14	17	0
	Isawa	2.2	1.3	0.13	14	0
	Hienuki	1.0	1.7	0.14	14	0
	Nishiiwai	0.6	2.8	0.16	15	0
	Esashi	0.4	19.9	0.14	13	0
	Shiwa	n.a.	1.0	0.16	15	0
	Total				236	95

Table 2: Predicted correlations with the prevalence of share tenancy

	risk-sharing	transaction costs
risk (P1)	+	+
wealth (P2)	-	0
community (P3)	0	-

Table 3: Estimates of tenancy contract distribution

dependent: percentage of share tenancy in tenanted paddy

% of share tenancy	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
risk								
CV of yield	323.741	323.290	310.621	225.641	214.615	216.490	4.416	195.406
	(7.66)***	(7.62)***	(7.47)***	(5.59)***	(5.41)***	(5.47)***	(2.75)***	(2.45)**
wealth								
cultivating area per	−20.549	−20.543	−10.652	−8.898	0.304	2.679	0.359	−3.565
household	(2.94)***	(2.94)***	(1.40)	(1.35)	(0.04)	(0.37)	(1.36)	(0.21)
output per household	0.005	0.006	0.002	0.002	−0.000	−0.000	−0.000	−0.009
(yen)	(0.68)	(0.68)	(0.24)	(0.27)	(0.02)	(0.06)	(0.27)	(0.52)
output from modern	−23.624	−22.676	−51.662	−15.395	−39.907		−1.144	24.496
sector	(1.20)	(1.07)	(2.41)**	(0.86)	(2.03)**		(1.24)	(0.49)
employment in modern						−105.011		
sector						(2.30)**		
community								
number of resident		−0.001			−0.003	0.001	−0.000	−0.005
household		(0.12)			(0.38)	(0.06)	(1.15)	(0.35)
employment in			−55.872		−53.973	−83.997	−1.737	−5.642
agriculture			(2.98)***		(2.83)***	(3.25)***	(2.27)**	(0.13)
paddy-field ratio				−19.712	−19.004	−18.962	−2.038	−54.631
				(6.11)***	(5.88)***	(5.88)***	(6.03)***	(3.23)***
constant	13.328	13.645	48.338	35.122	69.141	95.191	1.359	92.101
	(0.92)	(0.93)	(2.62)***	(2.59)**	(3.75)***	(3.94)***	(1.84)*	(2.50)**
observations	212	212	212	212	212	212	212	95
pseudo R^2	0.04	0.04	0.04	0.05	0.06	0.06	0.46	0.04
log likelihood	−904.70	−904.69	−900.33	−887.50	−883.04	−882.45	−76.85	−281.25

Notes: Absolute value of t-statistics in parenthesis. Column (7) displays Probit estimate with dependent variable calculated by the rule: 1 if percentage of share tenancy is more than 50% and 0 otherwise. Column (8) uses limited samples with village-level dependent data.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Estimates of tenancy contract distribution with industrial structure

dependent: percentage of share tenancy in tenanted paddy

	(1)	(2)	(3)	(4)	(5)
risk					
CV of yield	184.896	144.311	164.153	144.679	162.364
	(4.74)***	(3.58)***	(3.96)***	(3.61)***	(3.97)***
wealth					
cultivation area per household	3.989	4.445	4.483	4.469	5.762
	(0.53)	(0.59)	(0.55)	(0.59)	(0.71)
output per household (yen)	0.005	−0.005	−0.012	−0.003	−0.014
	(0.56)	(0.55)	(0.49)	(0.27)	(0.59)
output from modern sector	−42.224	−1.690	−5.040	−11.430	−6.713
	(1.76)*	(0.07)	(0.16)	(0.44)	(0.21)
community					
number of residents household	0.003	−0.000	−0.001	0.003	0.000
	(0.36)	(0.02)	(0.08)	(0.38)	(0.05)
employment in agriculture	−8.785	−7.545	−12.772	11.984	9.370
	(0.26)	(0.31)	(0.54)	(0.35)	(0.27)
paddy-field ratio	−22.074	−15.956	−18.468	−16.937	−18.764
	(6.38)***	(4.29)***	(4.80)***	(4.55)***	(4.91)***
industrialization (employment)					
fishery	44.434			39.472	44.310
	(1.05)			(0.74)	(0.95)
mining	−262.411			−218.746	−256.094
	(2.64)***			(1.72)*	(1.92)*
industry	69.647			87.733	79.297
	(0.74)			(0.95)	(0.85)
industrialization (output)					
livestock		182.265	0.123	186.793	0.125
		(1.79)*	(0.86)	(1.84)*	(0.88)
forestry		64.260	0.052	61.932	0.056
		(2.51)**	(1.51)	(2.42)**	(1.65)
fisheries		76.303	0.053	53.202	0.039
		(2.63)***	(1.71)*	(1.42)	(1.17)
mining		−24.277	−0.013	34.583	0.025
		(0.66)	(0.47)	(0.75)	(0.80)
modern			−0.003		−0.002
			(0.10)		(0.06)
sericulture					
employment	−39.473	−33.117	−35.771	−36.299	−39.446
	(2.45)**	(2.08)**	(2.22)**	(2.29)**	(2.47)**
output	−0.090	−0.012	−0.044	0.014	−0.003
	(0.39)	(0.05)	(0.19)	(0.06)	(0.01)
output^2	0.001	0.001	0.001	0.001	0.001
	(1.33)	(1.13)	(1.16)	(1.03)	(1.04)
constant	46.591	28.357	48.872	8.729	27.745
	(1.41)	(1.12)	(2.14)**	(0.25)	(0.81)
observations	212	212	212	212	212
pseudo R^2	0.07	0.07	0.07	0.08	0.07
log likelihood	−871.82	−869.32	−871.76	−867.05	−868.72

Notes: Absolute value of t-statistics in parentheses. Columns (2) and (4) uses output composition while (3) and (5) use output per household. Commerce for employment composition, agriculture and modern sector for output composition, and agriculture for output per household are excluded to avoid multi-collinearity.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Estimates of agricultural productivity

dependent: labor productivity

equation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS
dependent variable	rice	rice	rice	rice	total	total	total	total	rice	total
contract										
share tenancy	−0.010	−0.008	−0.020	−0.020	−0.059	0.049	−0.457	0.511	−0.009	0.601
(paddy)	(8.07)***	(5.94)***	(8.00)***	(5.57)***	(0.62)	(0.50)	(1.60)	(1.36)	(6.85)***	(1.47)
share tenancy					−0.112	−0.143	0.247	−0.544		−0.623
(field)					(1.10)	(1.39)	(0.93)	(1.64)		(1.73)*
tenancy										
% of tenanted area	1.029	0.958	0.376	0.352	92.802	81.896	82.032	93.622	1.070	91.974
(paddy)	(2.74)***	(2.53)**	(0.83)	(0.75)	(5.19)***	(4.19)***	(3.58)***	(4.16)***	(3.05)***	(4.04)***
% of tenanted area					−59.697	−41.359	−46.341	−52.627		−52.327
(field)					(2.98)***	(1.95)*	(1.88)*	(2.19)**		(2.15)**
input										
cultivation area per	1.010	1.012	0.784	0.772	32.077	32.237	27.277	37.173	1.112	36.209
household	(7.97)***	(7.94)***	(5.17)***	(4.79)***	(6.69)***	(6.74)***	(4.59)***	(5.86)***	(9.37)***	(5.65)***
output from	−0.003	−0.002	0.001	0.001	−0.011	0.032	0.048	−0.010	−0.001	−0.019
livestock sector	(1.04)	(0.61)	(0.44)	(0.46)	(0.11)	(0.33)	(0.44)	(0.09)	(0.56)	(0.18)
full-time farmers (%)	0.566	0.531	0.518	0.520	−3.209	−4.997	−2.932	−4.894	−0.005	4.096
	(2.16)**	(2.05)**	(1.76)*	(1.74)*	(0.32)	(0.52)	(0.28)	(0.48)	(0.02)	(0.37)
CV of rice yield		−2.229		0.252		−109.523		−139.486	−2.652	−137.131
		(3.22)***		(0.24)		(4.14)***		(3.83)***	(4.13)***	(3.70)***
sericulture									−0.959	16.330
employment (%)									(6.05)***	(2.21)**
constant	−0.108	0.225	0.724	0.726	26.663	41.898	34.443	36.942	0.786	27.020
	(0.45)	(0.86)	(2.22)**	(2.19)**	(2.97)***	(4.22)***	(3.02)***	(3.32)***	(3.04)***	(2.14)**
observation	215	212	212	212	217	212	212	212	212	212
adjusted R2	0.52	0.54	0.40	0.39	0.35	0.39	0.28	0.32	0.61	0.32

Notes: Absolute value of t-statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Summary statistics

	Share tenancy (n=62)			Mixed region (n=39)			Fixed-rent (n=135)			All samples (n=236)		
Variable	Mean	S.D.	Obs.	Mean	S.D.	Obs.	Mean	S.D.	Obs.	Mean	S.D.	Obs.
contract (%)												
share tenancy: paddy	94.64	14.05	62	59.24	30.83	39	6.52	16.38	120	40.54	43.39	221
share tenancy: field	85.21	19.81	62	48.53	39.52	39	9.79	14.86	135	36.00	39.24	236
tenancy (%)												
tenant household	57.23	18.7	62	49.62	27.72	39	67.73	12.08	135	0.62	0.19	236
paddy under tenancy	32.94	15.95	58	34.67	17.29	39	42.29	13.33	135	0.39	0.15	232
field under tenancy	28.14	13.88	62	18.29	10.16	39	27.25	12.5	135	0.26	0.13	236
risk												
CV of yield	0.24	0.09	56	0.16	0.05	38	0.15	0.07	133	0.18	0.08	227
productivity												
rice (koku/worker)	0.42	0.33	57	0.88	0.73	38	1.9	1.13	135	1.37	1.14	230
total (yen/worker)	55.52	23.24	62	89.38	40.36	39	91.08	35.63	135	81.46	36.99	236
wealth												
total arable land (cho/HH)	1.19	0.42	62	1.11	0.59	39	1.45	0.42	135	1.33	0.47	236
output (yen/HH)	676.4	311.53	62	890.48	609.19	39	709.98	358.62	135	730.99	404.72	236
community												
# of resident HH	572.66	418.05	62	611.72	709.07	39	615.2	363.08	135	603.45	449.64	236
employment in agric. (%)	66.62	21.02	62	64.09	26.5	39	77.64	19.12	135	0.73	0.22	236
paddy-field ratio	0.19	0.21	62	0.51	0.39	39	1.47	1.07	135	0.98	1.02	236
employment (%)												
full-time agric. HH	22.21	20.38	62	15.85	20.86	39	28.03	22.08	135	0.24	0.22	236
agriculture+livestock+forestry	66.62	21.02	62	64.09	26.5	39	77.64	19.12	135	0.73	0.22	236
fisheries	9.57	16.89	62	9.9	17.62	39	0.05	0.17	135	0.04	0.12	236
mining	0.08	0.22	62	1.59	5.79	39	0.75	3.35	135	0.01	0.03	236
industry	5.39	4.44	62	8.18	7.08	39	4.85	4.85	135	0.06	0.05	236
commerce	7.96	5.93	62	7.45	7.21	39	6.77	7.16	135	0.07	0.07	236
output (%)												
agriculture	46.94	20.23	62	54.61	25.26	39	71.91	21.75	135	0.62	0.25	236
livestock	4.81	5.34	62	3.06	2.51	39	3.21	3.51	135	0.04	0.04	236
forestry	27.47	17.41	62	15.25	10.2	39	10.34	11.15	135	0.16	0.15	236
fisheries	11.15	22.44	62	14.6	22.08	39	0.13	0.19	135	0.05	0.16	236
mining	0.38	1.58	62	2.33	9.28	39	2.33	11.63	135	0.02	0.1	236
modern sector (industry+commerce)	9.24	11.87	62	10.16	16.41	39	12.07	18.68	135	0.11	0.17	236
output (yen/HH)												
agriculture	281.44	121.95	62	433.69	247.32	39	475.11	167.32	135	417.39	191.18	236
livestock	26.61	19.2	62	23.38	18.52	39	20.76	24.23	135	22.73	22.19	236
forestry	195.32	185.59	62	120.31	82.8	39	72.27	88.12	135	112.54	131.25	236
fisheries	113.43	266.11	62	153.02	268.77	39	0.81	1.11	135	55.55	185.05	236
mining	2.54	10.89	62	65.79	356.35	39	35.08	228.94	135	31.61	225.55	236
modern sector (industry+commerce)	56.99	75.88	62	94.27	182.45	39	105.88	298.16	135	91.12	240.84	236
sericulture												
output per household	58.51	50.58	61	80.02	64.67	39	50.44	46.98	135	57.44	52.08	235
% of HH envolved	45.82	29.22	61	57.52	37.28	39	53.18	31.58	135	0.52	0.32	235