

**Land Ownership Transfer and Productivity:
Evidence from Taiwan**

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Abstract

Previous studies of tenancy and land reform programs suggest that these programs substantially increased agricultural productivity. However, these studies are limited to sharecropping environments. This paper investigates the productivity effect of the 1953 land ownership transfer program in Taiwan, where fixed-rental contracts predominated. This program transferred 27% of the paddy land to incumbent tenants in six months and was followed by exceptional agricultural performance. However, my findings suggest that when agricultural disaster is controlled for, this program actually had statistically insignificant effects on productivity. This result is explained by the predominance of fixed rental contracts and an almost permanent tenure situation before the land transfer.

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1. Introduction

The tenancy system, operating either in the form of sharecropping or fixed-rental, has long been employed as a classic example illustrating agency cost. On the one hand, in the sharecropping environment, tenants retain a partial share of their outputs. The theory of incentives and risk sharing predicts that this environment will reduce tenants' incentives to work and consequently lower productivity. On the other hand, in the fixed-rental environment, tenants keep the full residual of their outputs. Theory then predicts that tenants will supply effort at the first-best level and consequently achieve the same level of productivity as owner-cultivators. These two predictions have been empirically supported by Shaban (1987). Furthermore, this theory implies that contractual forms are crucial to productivity gains associated with agricultural property right reform programs, such as land reform programs that redistribute land ownership and tenancy reform programs that entitle incumbent tenants to claim a higher share of outputs and permanent tenure. If these reform programs are implemented in sharecropping environments, they should increase agricultural productivity; however, in fixed-rental environments, they should have no effects on productivity. Empirical studies of sharecropping, such as Jeon and Kim (2000) and Banerjee, Gertler, and Ghatak (2002), support the theory. However, it may be that reform programs increase productivity for other exogenous reasons, unrelated to contractual forms. To distinguish the agency cost theory from these effects, one must also look at fixed-rental environments. Surprisingly, no empirical studies have been conducted in fixed-rental environments.

Beginning in 1948, a drastic land reform initiative was implemented in Taiwan, where fixed-rental contracts predominated. This land reform initiative was composed of one major program and two minor programs. The major program was the private land ownership transfer [the 1953 Land-to-the-Tiller Program (LTTP)], which imposed a land holding ceiling and transferred the surplus land to incumbent tenants. The two minor programs were (1) the tenancy reform [the 1949 37.5% Farm Rent Limitation Program (37.5% FRLP)], which aimed to alleviate rent burdens and promote security of tenure and (2) the Public Land Sale Program (PLSP), which was carried out in nine stages¹. This land reform initiative was followed by exceptional agricultural performance. From 1954 to 1958, the annual growth rate of rice production averaged 3%. Consequently, this land reform initiative has been considered the essential factor in the agricultural success of Taiwan, a high-performing Asian economy (e.g., Fei, Ranis, & Kuo 1979; World Bank 1993).

In this paper, I test the implication that agricultural property right reform programs implemented in fixed-rental environments should have no effects on productivity. I perform this test by estimating the productivity effect of the Taiwanese private land ownership transfer program [the 1953 Land-to-the-Tiller Program (LTTP)]². LTTP provides several convenient

¹ The first stage of PLSP was implemented in 1948 with eight successive stages ending in 1976.

² Economists began to evaluate the effect of the Taiwanese land reform initiative on agricultural production in 1969. However, most of them focused on the effect of the minor tenancy reform program in 1949 but did not cover the major LTTP in 1953 (Cheung, 1969; Fan, 1995; Shang & Lin, 1997). The exception is Lu (1997). Lu uses national-level, time-series data on agricultural outputs and inputs for 1922-1966 to estimate the production effect of the overall land reform initiative. Although Lu's findings suggest that the land reform initiative has had a positive effect on production, his econometric approach is problematic because he could not establish causal

features that make it a better experiment than other land reform programs previously studied.

First, LTTP closely resembles an exogenous property right transfer in the land market,

providing a near-natural experiment. 27% of Taiwanese paddy land was transferred to

incumbent tenants between June 1953 and the end of 1953. Figure 1 shows that this enabled

121,000 farmer families to become owner-cultivators, which accounted for 17% of the farmer

families in 1953. Secondly, although development economists, such as Legros and Newman

(1996), have theorized extensively about the relationship between wealth inequality and

efficiency, the empirical work is rare. The LTTP program enables me to empirically

investigate whether a tradeoff between equity and efficiency exists.

From a number of government publications, I construct two data sets: an annual,

county-level panel data set for 1947-1962 and an annual, township-level panel data set for

1950-56.³ I conduct the empirical investigations as follows. First, the county-level trend of

rice yields shows that compared with the increase in other periods, rice yields did not increase

significantly in the period after the 1953 LTTP. Secondly, to capture the extent of the LTTP, I

use the proportion of transferred paddy land (TPL) in the LTTP in 1953 as the key measure.

Due to the disparity in land ownership distribution and the land holding ceiling, the LTTP was

implemented to a different extent across administrative units. This generates variation in TPL.

I employ a two-period first difference model in estimation. The county-level estimates show

connections using time-series data. A new econometric approach is needed.

³ Farm-level data are available in 1950 and 1951 only. Consequently, these data do not allow me to analyze the productivity effect of the 1949 tenancy reform program or the LTTP in 1953.

that regressions of rice yield increase on TPL and covariates of weather and government supplied chemical fertilizer yield statistically significant negative estimates of TPL. This implies that the LTTP would have reduced rice yields by 5%. However, further investigation suggests that this negative effect is driven by agricultural disaster, and when this variable is controlled for, the LTTP actually had statistically insignificant effects on productivity. Similarly, the township-level findings suggest that when agricultural disaster is controlled for, the LTTP had insignificant effects on productivity.

My findings suggest that although the LTTP greatly reduced inequality by converting landless tenants to owner-cultivators, it did not increase agricultural productivity⁴. If land reform programs are intended to increase productivity, they should be implemented in sharecropping environments, not fixed-rental environments.

This paper is structured as follows. Section 2 presents the institutional features of the tenancy system in the pre-LTTP period and outlines the implementation of the LTTP in 1953. Section 3 empirically investigates the productivity effect of the LTTP in three subsections—the pre-LTTP characteristics, the data sets, and the county and township-level analyses. Section 4 presents a sensitivity analysis and compares the results of my analysis of LTTP to the implications of some popular developments models. Section 5 concludes. Finally, Section 6 consists of a data appendix.

⁴ This is consistent with Shaban (1987), whose findings suggest that when land quality is controlled for, the

2. The Taiwanese Tenancy System and the LTTP

Before the land ownership transfer program (LTTP) was implemented in 1953, landless tenants and part-owners⁵ accounted for 62% of the overall farmer families; most farmer families were connected to the tenancy system. Consequently, before analyzing the productivity effect of the LTTP, one must consider the operation of the tenancy system.

Originally, the Taiwanese tenancy system was simply the product of an unregulated market in which land was relatively scarce. However, its operation was drastically changed by the 1949 tenancy reform program, in which the government reshaped the landlord-tenant relationship by extensively regulating the parameters of tenancy contracts. In this section, I analyze the unregulated tenancy system, the 1949 tenancy reform program, and then the implementation of LTTP in 1953. I also summarize the timeline of important events in Table 1 and the evolution of tenancy contracts in Table 2.

2.1 Unregulated Tenancy System Prior to 1949

Prior to 1949, the Taiwanese tenancy system had been well developed. According to the Japanese colonial government⁶ (1936), in 1935, 166 tenant-landlord associations⁷ had been established across Taiwan, and written tenancy contracts covered 68.24% of the rented land.

productivity difference between owner-cultivated and fixed-rental-cultivated plots is insignificant.

⁵ In terms of land holding, there were three types of farmers in Taiwan: tenants, part-owners, and owner-cultivators. Tenants were farmers who did not have their own land but rented land from landlords. Part-owners were farmers who had their own land but also rented land from landlords. Owner-cultivators were farmers who had their own land and did not rent land from other people.

⁶ From 1895 to 1945, Taiwan was a Japanese colony. The Chinese Nationalists took control in 1945.

⁷ These associations were not government organized but organized by landlords and tenants. Landlords and

To promote the operation of the tenancy system, these tenant-landlord associations introduced innovations in crop production to farmers and prevented and mediated tenancy disputes.

These associations prevented tenancy disputes by encouraging their members to use written contracts, whose format was stipulated by the association.

In terms of the contract form, while newly cultivated land with uncertain output was sharecropped, fixed-rental contracts predominated in Taiwan before 1949 (Barrett, 1984; Yeh, 1994). Wickberg points out that when output became stable, sharecropping was replaced by fixed-rental contracts (as cited in Barrett, 1984). Taiwan has been densely populated, and most arable land has been cultivated since the 18th century, so by 1945 outputs had become stable. Consequently, fixed-rental contracts predominated. Moreover, Wang points out that fixed-rental contracts predominated in both paddy and dry land in Taiwan (as cited in Fan, 1995). Similarly, in 1928, Kawada investigated tenancy contracts in central Taiwan-- the Taichung district. He found that although tenants paid rents in four ways--sharecropping, fixed-rental fee paid in kind, money paid as substitute, and money⁸, fixed-rental fee paid in kind was by far the most popular. In paddy land, 87.1% was fixed-rental fee paid in kind, while only 4.6% was sharecropping⁹ (as cited in Barrett, 1984).

Since fixed-rental contracts predominated, the rental fee was determined based on the expected harvest, not the actual harvest, although according to the written contracts employed

tenants were, however, encouraged to operate such associations, by the Japanese government through subsidies.

⁸ However, Kawada did not explain that when tenants paid their rents using money paid as substitute or money, the amount of rent was a share of output or a fixed fee.

by the tenant-landlord associations, tenants were entitled to limited liability for their rent burdens: in years of poor harvest, if tenants failed to pay the full amount of rental fee, they were entitled to negotiate to reduce the rental fee.

. In Taiwan, the rental fee was commonly reported by the rent ratio-- the nominal amount of the rental fee divided by the average harvest. From 1919 to 1937, the rent ratio reached one-half in paddy land (Yeh, 1994). In addition, the rent amount depended on soil quality, land type, and geographical location (Fan, 1995). Wang investigated rent ratios across Taiwan in 1937. His study indicates that the rent ratio was higher in fertile land than in barren land. Also, in terms of land type, the rent ratio was higher in paddy land than in dry land. In paddy land the rent ratio averaged 50%, while in dry land the rent ratio averaged 35% only. However, in terms of geographical location, the study does not show any obvious pattern (as cited in Fan, 1995).

In this unregulated tenancy system, the majority of contract durations were over 3 years, and the most popular contract duration was 3-5 years. Wang investigated the contract duration in central Taiwan-- the Taichung district. His study shows that in both paddy and dry land, 3-5 year contracts predominated. Furthermore, contracts with durations longer than 3 years outnumbered contracts shorter than two years. (as cited in Yeh, 1994). Similarly, the Japanese colonial government investigated contract durations in the 1920s in southern Taiwan-- the Tainan district, where they found that the most popular contract duration was 3-4 years (as

⁹ The remaining was money paid as substitute (6.4%) and money (1.9%).

cited in Yeh, 1994). Finally, in the written contracts employed by the tenant-landlord associations, the contract duration was explicitly stated to be five or six years or longer. This also suggests that the majority of contract durations were over 3 years.

Finally, security of tenure was extensively defined in the written contracts employed by the tenant-landlord associations. In terms of contract cancellation, if one party canceled the contract before it expired without proper reasons, the other party was entitled to compensation. However, landlords could cancel the contracts if their tenants delayed rental payments without proper reasons or left the land uncultivated. In terms of contract renewal, if none of the parties proposed to terminate the contract six months before it expired, this contract would be automatically renewed. However, incumbent tenants might fail to renew the contracts if (1) tenants delayed their rental payments; (2) landlords wanted to repossess the land for own cultivation; or (3) tenants were unable to offer landlords higher rents than other competitors. Therefore, although tenants were not entitled to inheritable and permanent tenure on the land they leased, they could not be rotated arbitrarily.

2.2 The Tenancy Reform Program in 1949

The operation of the Taiwanese land rental market was transformed by the 1949 tenancy reform program [the 37.5% Farm Rent Limitation Program (37.5% FRLP)], which aimed to alleviate rent burdens and promote security of tenure. However, this program did not change the form of tenancy contracts. Fixed-rental contracts remained predominant. Under this program, tenants could pay no more than the rent ceiling of 37.5% of their expected annual

yields¹⁰.

Furthermore, tenants were entitled to limited liability for their rent burdens. In years of poor harvest, tenants could petition the local government to reduce the rental fee. After receiving the petition, the local government would investigate the extent of the damage and then determine the amount of reduction. If the damage was so severe that the actual harvest was less than 30% of the expected amount, the rental fee would be totally waived.

To promote security of tenure, written contracts with explicitly stated contract parameters were required, including contract duration, renewal, and registration and incumbency qualification. Contract duration was stipulated to six years. When the contract expired, incumbent tenants could reserve the right to renew. Landlords could not reject tenants' renewal requests unless three requirements were fulfilled—(1) repossessed land had to be self-cultivated; (2) repossession of the land had to be essential to the landlord's income; and (3) this action was not allowed to cripple the tenant's standard of living. Furthermore, to avoid tenancy disputes¹¹, contract registration with the local government was required. To renew or terminate contracts, landlords and tenants had to petition the office. Finally, if landlords wanted to sell their land, their incumbent tenants reserved the right to purchase the land. If the incumbent tenants wanted to purchase the land but the landlords did not sell the land to them, landlords had to compensate their incumbent tenants. These stipulations greatly

¹⁰ Government officials and landlord and tenant representatives appraised land to determine expected annual yields.

¹¹ Tenancy disputes occurred primarily because (1) landlords refused to update contracts according to the

shifted the power from landlords to tenants and suggested that tenants had almost permanent tenure after 1949.

Landlords resisted the 1949 tenancy reform program, but this resistance was effectively overcome by the Chinese Nationalist government¹² and did not affect the implementation of the tenancy reform program. At the end of 1949, the contracts that complied with the tenancy law covered 74.32% of the rented land. In 1952, this percentage increased to 85%.

2.3 The LTTP in 1953

According to the 1952 general land ownership census, 70% of Taiwanese landholders had less than 1 chia¹³ of land, and the total area they owned accounted for only 25% of total cultivated land. To increase equity in land holding¹⁴, the Chinese Nationalist government launched the LTTP in June, 1953 and completed it in all townships by the end of 1953. In order to take away land from large landlords, a land holding ceiling, which was subject to the

tenancy law and (2) the two parties could not agree with the method of payment or the grade of land.

¹² The Chinese Nationalist government could overcome the resistance of landlords for several reasons. First, the Chinese Nationalist government was a foreign administration; its officials were not connected with the Taiwanese landlords. Secondly, although according to the tenancy law, disobedient landlords should be sentenced for 1-3 years, landlords were actually threatened with death if they did not comply with the tenancy law. These threats were credible because thousands of the Taiwanese people, mainly the elite, had been executed in the 1947 rebellion (the February Twenty-Eighth Event).

¹³ A chia is equivalent to 2.4 acre or 0.97 hectare.

¹⁴ The LTTP was also the result of some external conditions. In 1950, the breakout of the Korean War and the resulting change in US foreign policy to China ended the civil war crisis that the Chinese Nationalist Government encountered. The Nationalist government also wished to implement the LTTP in order to take firmer control of Taiwanese society, and to increase agricultural production to support the Mainland Chinese fleeing to Taiwan from 1949 to 1950. The influx of Mainland Chinese accounted for 13% of the Taiwanese population in early 1950s, though most were members of the armed forces, government personnel, or teachers, not farmers.

quality and type of land, was imposed. Large landlords were forced to sell any land in excess of the land holding ceiling to the government. This excess land was in turn sold to incumbent tenants¹⁵. I illustrate the amount of land that each landlord family could retain as follows¹⁶.

	Paddy Land (chia)	Dry Land (chia)
Grade A ¹⁷	1.5	3
Grade B	3	6
Grade C	4.5	9
Grade D	6	12

For each grade of land transferred in the LTTP, the compulsory purchase price equaled the resale price. The resale price was stipulated to be 2.5 times the expected annual yield, as appraised by government officials and landlord and tenant representatives. This was typically substantially below the market value¹⁸. To ensure that incumbent tenants were able to purchase land, tenants who acquired land paid the resale price to the government through a

¹⁵ Since incumbent tenants reserved the right to purchase land, most of the land was transferred directly from landlords to their incumbent tenants. Therefore, the LTTP changed the land ownership but left the operational farm size more or less intact.

¹⁶ If the land of landlords was scattered in different places, landlords first retained the land in the township of their residence, then they retained the land in the county of their residence. If all of the land was in the same township, what landlords could retain was determined by (1) the distance between the land and the landlord's residence and (2) the economic conditions of their incumbent tenants.

¹⁷ Since the 18th century the government in Taiwan had appraised land to determine its grade, for property tax purposes. The tax burden was the same for the land that had the same grade and use. In 1952, one year before the LTTP was implemented, the Chinese Nationalist government re-appraised the land and updated grades. Land was divided into 26 quality grades, with the first grade the most fertile and the 26th grade the least fertile. Furthermore, to determine the land holding ceiling, the first sixth grades were grouped as Grade "A", the 7th to 12th grades were grouped as Grade "B", the 13th to 18th grades were grouped as Grade "C", and the 19th to 26th grades were grouped as Grade "D".

ten-year, twenty-installment plan¹⁹ so that their mortgage liability would not exceed their previous rent burdens²⁰. On average, the annual mortgage payment amounted to 30% of the expected paddy land harvest, slightly lower than tenants' previous rent burdens. However, tenants were not entitled to limited liability for their mortgage payments. Although in years of poor harvest, the mortgage could be postponed, it had to be made up in subsequent years so that the full amount of the mortgage payment could not be reduced. If tenants delayed their mortgage payment for four months, their land would be repossessed by the government and the amount of paid mortgage would not be returned²¹.

Additionally, to ensure the acquired land was used for tenants' own-cultivation, land leaseability and transferability were stipulated. Tenants were not allowed to lease out their acquired land. If they were unable to cultivate the land on their own, they could petition the government to purchase the land. In addition, before the full mortgage was paid back in 1962,

¹⁸ According to Ho (1978), the true market value ranged from 4.5 to 8 times the expected annual yield.

¹⁹ Landlords received 30% of the compulsory purchase price through government enterprise stocks and 70% through land bonds in kind, which were redeemed from the government through a ten-year, twenty-installment payment plan.

²⁰ According to the Taiwan Food Statistics Book, prepayments accounted for less than 6% of the total mortgage payments each year, and the payment on-time rate was more than 97% each year. Therefore, these statistics suggest that less than 6% of the tenants who acquired land paid back the full mortgage before 10 years, and most of them paid back the full mortgage on time.

²¹ I illustrate the detailed penalty regulation as follows.

Period of Delay	Penalty
Less than 1 month	2% of the mortgage
1-2 months	5% of the mortgage
2-3 months	10% of the mortgage
3-4 months	15% of the mortgage
More than 4 months	The land would be repossessed by the government, and the paid mortgage would not be returned.

the acquired land was not transferable and could not be used as collateral for loans.

In summary, various aspects of the tenancy system were transformed in the 1953 LTTP, summarized in the third panel of Table 2. In terms of the magnitude of the LTTP, the take-up rate amounted to 95%. At the end of 1953, 20% of the private cultivated land had been transferred²². Tenant families who acquired land accounted for 27% of all farmer families. Among the tenant families who acquired land, 77% of them acquired less than 1 chia of land, and the area they had accounted for 44% of the total transferred land.

3. Empirical Investigations of the Productivity Effect from the 1953 LTTP

3.1 Pre-LTTP Characteristics

In the Taiwanese county system, there were 20 counties that were directly under the Taiwanese Provincial Government. However, these 20 counties were composed of 2 groups—15 rural counties, which were called “hsien”, and 5 urban counties, which were called “shih”. Based on these 20 counties, I report the pre-LTTP characteristics, which include demographic and agricultural characteristics, the characteristics of owner-cultivator and tenant farmer families of rice, and the characteristics of rural credit.

Table 3 shows the demographic and agricultural characteristics in the pre-LTTP period (1950-52). The area of rural counties was on average 15 times larger than that of urban counties. The urban counties exhibited a much higher population density, about ten times higher than that in the rural counties. However, the urban counties showed a much lower

²² For paddy land, this percentage was 27%.

percentage of agricultural population, about one-fifth of that in the rural counties. Farmer associations were prevalent in both types of counties. More than 70 % of the sub-units established their township-level farmer associations. In terms of farmer family composition, 63 % of the farmer families were connected to the tenancy system, and 42 % of them were landless tenants.

Table 4 illustrates the characteristics of owner-cultivator and tenant farmer families of rice between 1950 and 1951. In terms of the family size, tenant families on average were slightly smaller than that of owner-cultivators by 0.9 person. In terms of the operational farm size, the area that tenants cultivated averaged 86% of the area that owner-cultivators cultivated. However, these two differences are not statistically significant. Moreover, owner-cultivators and tenants were not statistically different in terms of persons able to work, annual expenses, and per-capita income²³.

On the other hand, they were statistically different in terms of net wealth, total income, and annual profits. In terms of net wealth, tenants were significantly poorer. Tenants only possessed 32% of the wealth compared to owner-cultivators. In terms of total income, the amount that tenants earned averaged 87% of that owner-cultivators earned. Moreover, tenants only earned 75% of total profits compared to owner-cultivators. The low profitability of

²³ Both owner-cultivators and tenants on average earned more than the national average because the ballpark figure of the 1951 per-capita income amounted to NT\$ 1,554. Although the per-capita national income was not available in 1951, I calculated its ballpark figure by deflating the data on the 1952 per-capita national income by the corresponding wholesale price index. By this way, the 1951 per-capita income amounted to NT\$1,554. Between 1950 and 1951, the exchange rate of the NT dollar to the US dollar was 40.

tenants also exhibits at the level of per unit of land (82%), per capita (85%), and per person able to work (74%).

In terms of the characteristics of rural credit, Table 5 illustrates the sources of demand for rural credit in 1949 and suggests that the loans were primarily used as consumption credit (34%), fixed capital (20%), and working capital (18%). Additionally, the loan size amounted to about 15% of the income of farmer families²⁴, and tenants only borrowed 90% of the loans compared to owner-cultivators. For owner-cultivators and tenants alike, they both obtained credit primarily from personal network. The credit from institutional lenders accounted for less than 20 %, while the credit from landlords was even less²⁵. Compared to owner-cultivators, tenants relied more on local lenders (by a margin of 3.1 percentage points) and landlords (by a margin of 4 percentage points).

3.2 Data Sets

From a number of government and bank publications, I construct an annual, county-level data set for 1947-62²⁶ and an annual, township-level data set for 1950-56. The county-level data set includes variables on (1) rice yields, (2) the proportion of transferred paddy land in

²⁴ The number of 15% is calculated from the following information: (1) the average 7-month loan size amounted to NT\$ 205.09; (2) the estimated annual income of owner-cultivators amounted to NT\$ 2,528; (3) the estimated annual income of tenants amounted to NT\$ 2,220.

²⁵ Owner-cultivators did not rent land from landlords. Thus, for owner-cultivators, the credit from landlords refers to the credit borrowed from lenders who also rented out their land.

²⁶ I choose the period 1947-62 for the following reasons. First, since the data for 1945-46 are incomplete, I choose to start with 1947 to avoid this problem. Secondly, since the tenants who acquired land in the LTTP paid back the full amount of mortgage in 1962, I choose to end with 1962 to avoid the problem caused by the increase of disposable income of tenants beginning in 1963.

the LTTP in 1953 (TPL), (3) the proportion of rented paddy land in 1949 (RPL), (4) the per-hectare amount of government supplied chemical fertilizer (GSCF), (5) weather (temperature and rainfall), and (6) the proportion of production loss from agricultural disaster (PLAD). However, the township-level data set only includes the first three variables since the data on GSCF, PLAD, and the weather data are not available at the township level.

The data sources of these five variables are shown in Table 6. For rice yield, the county-level data are taken from the Taiwan Agricultural Yearbook, and the township-level data are taken from the Taiwan Food Statistics Book. Both of these publications contain per-harvest²⁷ information on rice yields, and their data are consistent at the county level. For TPL, the data are taken from three sources. First, The Land Reform Initiative in Taiwan (Tang, 1954) contains county-level information surveyed by the Land Bureau of the Taiwan Provincial Government. Secondly, in 1954, the Police Department of the Taiwan Provincial Government published a handwritten manuscript on the LTTP implementation. This manuscript contains information on TPL for 5 urban counties and townships in 15 rural counties. Thirdly, although several county governments published reports on the LTTP implementation, I only find three counties that published reports containing township-level information on TPL²⁸. Figure 2 compares the county-level TPL data taken from the police department and the land bureau and shows that although the data from the police department almost co-move with those from the land bureau, these two TPL measures diverge in

²⁷ In Taiwan, there are two rice cropping seasons in a year.

Pengtung Hsien. This divergence causes Pengtung to be the influential observation monitored in the later analysis²⁹.

Finally, because of the redrawing of the county system in 1950³⁰ and the differences of the unit of coverage and frequency of the published data, part of the published data are modified. I detail these modifications in Section 6—the data appendix.

3.3 County and Township-Level Analyses

To analyze the productivity effect of the LTTP, since the proportion of transferred paddy land in the LTTP in 1953 (TPL) measures the extent of paddy land, where rice is grown, that was transferred from landlords to tenants, I use it as the key measure to capture the extent of the LTTP. Due to the disparity in land ownership distribution and the land holding ceiling, the LTTP was implemented to a different extent across counties. This generates the variation in TPL. If the LTTP was implemented to a larger extent in a county, a higher percentage of paddy land would be transferred in this county and hence TPL would be larger.

The dependent variable that I use is the increase of rice yield between post-LTTP and pre-LTTP periods. If the LTTP had a positive effect on productivity, I expect this increase would be larger in a county with a larger value of TPL. I choose the post-LTTP rice yield to be the average yield between 1953 and 1955. This short time period is justified because it

²⁸ These three counties are Taichung, Yunlin, and Chiayi Hsiens.

²⁹ The county-level TPL data from the three county governments are consistent with those from the land bureau.

³⁰ During 1945-49, the old county system was composed of 16 counties (7 hsiens and 9 shihs); while in 1950, with 5 shihs remained unchanged, these counties were organized into the current 20 counties (15 hsiens and 5 shihs). I use the current county system.

prevents other unaccounted factors from affecting productivity but also allows sufficient time to reap the full productivity gain resulting from the LTTP. Tenants who acquired land started to pay their mortgage in the first harvest of 1953, and the rice growing season ranges from 4 to 5 months in Taiwan. Similarly, I choose the pre-LTTP rice yield to be the average yield between 1950 and 1952. Although this time period is not sufficiently distant from the shock, it comes completely after the tenancy reform program in 1949. This purifies my analysis.

I organize the analysis on the productivity effect of the LTTP as follows. First, Figure 3 illustrates the trends of rice yield in five rural counties. This figure indicates that except for one county, rice yield increased steadily in the 5 sub-periods. However, if we compare the increase of rice yield between any two consecutive sub-periods of each county, this figure shows that only 1 county had a larger increase of rice yield between 1950-52 and 1953-55. The rice yields in the other fifteen counties show similar trends. Overall, rice yield increased steadily in the 5 sub-periods in 17 out of 20 counties, and only 3 counties had a larger increase of rice yield between 1950-52 and 1953-55. This suggests that compared with the increase in other sub-periods, rice yield did not increase significantly in the sub-period right after the 1953 LTTP.

I also analyze the relation between the increase of rice yield between 1950-52 and 1953-55 (ΔQ) and the proportion of transferred paddy land in the LTTP in 1953 (TPL) using the whole sample of 20 counties (Figure 4). This analysis does not show a clear correlation,

although the point estimate, -0.18, is negative and significantly different from zero at the 5% level. Additionally, this analysis suggests a regional difference among rural counties. The LTTP was implemented to a larger extent in the northern counties compared to the southern counties. However, rice yield increased less in the northern counties.

Regarding this regional difference, Table 7 shows that during the period from 1950 to 1956, rice yields and the proportion of production loss from agricultural disaster³¹ (PLAD) have the same trends in these two regions. Rice yields and PLAD were not statistically different in these two regions in 1950-1953 and 1956, but they were different in these two regions in 1954 and 1955. This suggests that the regional difference in rice yields may not be driven by the LTTP but agricultural disaster.

In terms of the econometric approach, I employ a two-period first difference model³². I assume that rice yield depends on the following exogenous variables³³: (1) the LTTP, (2) the per-hectare amount of government supplied chemical fertilizer (GSCF), (3) the rural reconstruction projects implemented by the Joint Commission on Rural Reconstruction (JCRR), a bilateral government agency responsible for agricultural development, (4) weather (temperature and rainfall), and (5) production loss from agricultural disaster (PLAD).

³¹ Agricultural disaster includes the damage caused by insects, diseases, such as rice blast, and extreme weather conditions, such as drought, rain, flood, wind, tornados, and typhoons.

³² Although the fixed effects model will generate identical results, I choose the two-period first difference model because it allows me to show the relation between rice yield increase and TPL using a scatter plot (Figure 4).

³³ I do not include other exogenous variables, such as irrigation facilities and price variables (the local market price of rice and the informal interest rate), for the following reasons. First, irrigation facilities are a given requirement for paddy land. Secondly, due to little price variation across counties, the estimates of the price

Chemical fertilizer played a crucial role in the Taiwanese intensive rice farming, and due to the US Aid, the amount of government supplied chemical fertilizer doubled from 1950 to 1955³⁴. Therefore, although the use of chemical fertilizer is an endogenous choice, I include the exogenous variable of GSCF to control for the bias resulting from the possibility that the distribution of government supplied chemical fertilizer was correlated with the implementation of the LTTP. Additionally, beginning in 1950, the Joint Commission on Rural Reconstruction (JCRR), a bilateral government agency created by the American and Taiwanese governments, implemented extensive rural reconstruction projects in Taiwan³⁵. Since these projects were devoted to both institutional and technological improvements, they would have been crucial to the Taiwanese agricultural performance. Furthermore, these projects expanded rapidly in the 1950s. From 1950 to 1956, the JCRR project expenditure increased from 1% to 2.5% of total value of agricultural production. I would have liked to include the JCRR variable to control for the bias resulting from the possibility that the expansion of the JCRR projects was correlated with the implementation of the LTTP. However, because the data on the JCRR project expenditure are only available at the national level, I use a time dummy variable to proxy for the effects of institutional and technological

variables are insignificant. Therefore, I leave them out.

³⁴ From 1950 to 1955, the amount of government supplied chemical fertilizer increased from 231 to 460 thousand tons per year, while rice cultivated area remained around 780 thousand hectare per year.

³⁵ According to Shen (1970), these extensive projects included promoting the operation of farmers' associations, the setup of an agricultural financial system, agricultural education and extension, innovations in crop and livestock production, assistance in fisheries, forestry and soil conservation, flood control and water resources development, rural electrification, and rural health education and sanitation development.

improvements resulting from the JCRR projects and other sources.

I use TPL to proxy for the extent of the LTTP. Additionally, I use PLAD to proxy for the damage caused by agricultural disaster. Formally,

$$(1) \Delta \ln Q_{ct} = \beta_0 + \beta_1 (TPL_{c53}) + \beta_2 (\Delta PLAD_{ct}) + \beta_3 (\Delta \ln GSCF_{ct}) + \beta_4 (\Delta \ln T_{ct}) \\ + \beta_5 (\Delta \ln R_{ct}) + (\Delta \varepsilon_{ct})$$

Variable	Definition
<i>Subscript c</i>	County
<i>Subscript t</i>	Time period; $t=50-52$ or $53-55$
$\Delta \ln Q_{ct}$	Difference of rice yields between 1950-52 and 1953-55 (kg/ha)
TPL_{c53}	Proportion of transferred paddy land in the LTTP in 1953
$\Delta PLAD_{ct}$	Difference of proportion of production loss from agricultural disaster between 1950-52 and 1953-55
$\Delta \ln GSCF_{ct}$	Difference of government supplied chemical fertilizer between 1950-52 and 1953-55 (kg/ha)
$\Delta \ln T_{ct}$	Difference of mean temperature between 1950-52 and 1953-55 (0.1C)
$\Delta \ln R_{ct}$	Difference of annual rainfall between 1950-52 and 1953-55 (0.1mm)
$\Delta \varepsilon_{ct}$	Difference of omitted variables

The township-level TPL data are only available in the 15 rural counties. Therefore, to facilitate the comparison of county and township-level findings, I perform the baseline estimation using the sample of 15 rural counties. First, summary statistics are reported in Table 8. The county-level data shows that in 1949, four years before the LTTP, 60% of the paddy land was rented. In the LTTP in 1953, 27% of the paddy land was transferred. Moreover, the increase of rice yield between 1950-52 and 1953-55 averaged 223 (kg/ha), which amounted to 12% of the rice yield in 1950-52. However, in 1953-55 the production loss from agricultural disaster averaged 2.4 times of that during 1950-52. This suggests that more agricultural disaster hit Taiwan in the post-LTTP period. In terms of government supplied

chemical fertilizer, its intensity was 46% higher in the post-LTTP period. Finally, mean temperature remained almost the same before and after the LTTP, while annual rainfall was 7% lower in the post-LTTP period.

Secondly, using the county-level TPL information surveyed by the Land Bureau, I report OLS in first difference estimates in Table 9. Column A shows that when technological improvements are not controlled for, regressions of rice yield increase on TPL yield statistically significant positive estimates of TPL. This suggests that the LTTP contributed to the agricultural growth in Taiwan, which is consistent with the literature (e.g., Fei, Ranis, & Kuo 1979; World Bank 1993). However, when technological improvements are controlled for, Column B shows that these regressions yield statistically significant negative estimates of TPL. Since the proportion of transferred paddy land averaged 27%, this suggests that the LTTP would have reduced rice yields by 6%. Nevertheless, these negative estimates are sensitive to the inclusion of production loss from agricultural disaster (PLAD). Column C shows that when this variable is controlled for, the estimates of TPL become statistically insignificant. This insignificance also holds when the covariates of weather and government supplied chemical fertilizer are included (Column D & E). Moreover, Column F-J shows that similar results are generated using the township-level data. In summary, the county and township-level OLS estimates suggest that when the damage from agricultural disaster is controlled for, the LTTP would have had insignificant effects on productivity.

4. Sensitivity Analysis and Implications of Some Popular Development Models

In this section, I perform a series of sensitivity analysis to check whether the insignificant first difference estimates of TPL are robust to data sources, sample size changes, econometric methods, and windows of measurement. In addition, since some popular development models also imply the productivity effect of the LTTP, I compare my findings to their implications.

4.1 Sensitivity Analysis

In terms of data sources, since the county-level TPL data were surveyed by the land bureau and the police department, I check the robustness by performing the baseline estimation but employing the TPL data surveyed by the police department (Column A of Table 10). This estimation suggests that the insignificant estimate of TPL is robust to data sources.

In terms of sample size changes, I check the robustness by performing the same estimation but using the whole county-level sample (20 counties), the whole township-level sample that includes Pengtung Hsien, and the township-level sample of northern and southern counties (Column B-E of Table 10). These four estimations suggest that the insignificant estimate of TPL is robust to sample size changes.

In terms of econometric methods, I employ instrumental variables to control for the potential bias resulting from measurement errors and omitted variables. The county-level TPL data are taken from two sources. Therefore, when employing one set of TPL data as the LTTP

measure, I can use the other set as the instrumental variable to control for measurement error bias. The other set of TPL data could be a good instrument if the values of these two data sets are correlated in their true values only. The IV estimates are reported in Column A of Table 11, and they also suggest that the LTTP would have had insignificant productivity effects.

On the other hand, since TPL would be correlated with the difference of omitted variables, such as the implementation of JCRR projects, I use the proportion of rented paddy land (RPL) in 1949 as the instrument to control for this source of bias. RPL could be a bad instrument if it is correlated with the omitted variables. For example, RPL could be correlated with the implementation of rural reconstruction projects. A higher value of RPL suggests a higher proportion of tenants. Since tenants were significantly poorer than owner-cultivators, the government might implement more rural reconstruction projects in counties with higher values of RPL to reduce the inequality across counties. This will cause RPL to be correlated with the implementation of rural reconstruction projects and consequently jeopardize the instrumental-variable estimation. However, according to Shen (1970), there is no evidence showing that more rural reconstruction projects were implemented in counties with higher values of RPL. Therefore, this scenario can be excluded.

Actually, since RPL measures the extent of rented paddy land in 1949, before the estimation period (1950-1955), it would not affect the dependent variable except through TPL. This suggests that RPL could be a good instrument. Moreover, the significant 1st stage estimates of RPL suggest that it is highly correlated with TPL (Column B and C of Table 11).

Finally, the insignificant 2nd stage estimates of TPL also suggest that the LTTP would have had insignificant productivity effects.

In terms of windows of measurement, since it might take a longer time to reap the full productivity gain, I check the robustness by performing the same baseline estimation but extending the post-LTTP period to 1954-56 (Column D and E of Table 11). The estimations suggest that the insignificant estimates of TPL are robust to data sources.

4.2 Implications of Some Popular Development Models

The theory of incentives and risk sharing implies that fixed-rental contracts cause tenants to supply effort at the first-best level. Since fixed-rental contracts predominated in Taiwan, this implies that the LTTP should not have affected tenants' effort levels and consequently should have no effect on productivity. This implication is supported by my findings, which suggest that the LTTP would have had statistically insignificant productivity effects.

However, the theory of incentives and limited liability (Ghatak & Pandey, 2000) suggests that LTTP might have a positive effect on productivity. In the pre-LTTP period, tenants could negotiate to reduce the rental fee in years of poor harvest; while in the post-LTTP period, they were responsible for the full amount of mortgage irrespective of the level of harvest. This entitlement diminished tenants' cost of low output realizations and consequently might have distorted their incentives, relative to the post-LTTP period, when no such negotiation was possible. If true, this suggests that the LTTP might have a positive effect on productivity.

Moreover, Banerjee, Gertler, & Ghatak (2002) argue that greater security of tenure may

encourage tenants to invest more because tenants are more likely to reap the profits from these investments. Since the LTTP increased security of tenure by shifting tenants from almost permanent tenure to acquiring their own land, this suggests that the LTTP might have increased productivity for this reason³⁶.

In the Taiwanese tenancy system, landlords possessed a superior hierarchical position and earned much higher incomes. Although this system has long been considered the major barrier to agricultural growth, Rosen's (1982) theory of authority and control suggests that this tenancy system might have operated more efficiently than individual ownership. Based on Rosen's theory, the superior talents of landlords enabled them to possess supervisory positions, and this could have significantly increased productivity of rented land because in this scenario, landlords' better knowledge could guide the ordinary tenants and, hence, increase the productivity. Thus, the LTTP, which broke up the landlord-tenant relationship, might have an adverse effect on productivity. However, if landlords' superior talents were crucial to agricultural production, tenants who acquired land would likely be willing to pay their former landlords for consultation. No such consultations apparently took place.

LTTP might have also affected landlords' provision of financial assistance to their tenants through interlinked contracts. In a fixed-rental environment, landlords have an

³⁶ Nevertheless, the transferred land was not allowed to lease out or transfer. Although this ensured the land was used for tenants' own-cultivation, this restricted their methods to realize land improvements made through investments. According to Besley (1995), this restriction would limit tenants' investment incentives and consequently limit the positive productivity effect contributed by investments.

incentive to provide easy credit to their tenants in order to reduce the likelihood of low output realization when landlords, under limited liability, thus trading off loss of interest income and loss of rental fee. Braverman & Stiglitz (1982) argue that interlinked contracts enable tenants to employ more working capital and hence increase productivity. This suggests that the LTTP, which broke up the landlord-tenant relationship and consequently erased the interlinked contracts between them, might have had a negative effect on productivity. However, this effect is not likely to be large since landlords were not the main credit providers of tenants. In 1949, only 5.5% of total credit was borrowed from landlords³⁷.

5. Conclusion

Using the county and township-level data, I present a series of empirical investigations on the productivity effect of the LTTP. First, the county-level trend of rice yields shows that compared with the increase in other periods, rice yields did not increase significantly in the period after the 1953 LTTP. Secondly, the county and township-level analyses suggest that when agricultural disaster is controlled for, the LTTP actually had statistically insignificant effects on productivity. In summary, my findings suggest that although the LTTP greatly reduced inequality by converting landless tenants to owner-cultivators, it did not increase agricultural productivity. If land reform programs are intended to increase productivity, they should be implemented in sharecropping environments, not fixed-rental environments.

³⁷ Data Source: Agricultural Basic Survey: Report on Investigation of Agriculture Finance (1950)

6. Data Appendix (To Be Revised)

From a number of government publications, I construct an annual, county-level and township-level data set for 1950-56. The county-level data set includes variables on (1) rice yields, (2) proportion of transferred paddy land in the LTTP in 1953 (*TPL*), (3) proportion of rented paddy land in 1949 (*RPL*), (4) proportion of production loss from agricultural disaster, (5) per-hectare amount of government supplied chemical fertilizer, and (6) weather (temperature and rainfall). However, the township-level data set only includes the first three variables since the data on proportion of production loss from agricultural disaster and government supplied chemical fertilizer and the weather data are not available at the township level. The data sources of these six variables are reported in Table 6. In addition, I calculate and modify the published data as follows.

Rice Yield (Q) This information was acquired from published, per-harvest data on rice yield and cultivated area of rice. Since all the data on rice yield are per-harvest information, I calculate the annual information using the corresponding data on cultivated area of rice for the weights.

Proportion of Transferred Paddy Land in the LTTP in 1953 (TPL) This information was acquired from the published, annual data on area of paddy land and area of transferred paddy land in the LTTP. I calculate this proportion by dividing the area of transferred paddy land in the LTTP by the area of paddy land.

Proportion of Rented Paddy Land in 1949 (RPL) This information was acquired from the

published, annual data on the operation of paddy land in 1949. These published data includes district and township level information on the area of rented and self-cultivated paddy land in 1949. By adding up the corresponding district-level data, I acquire the county-level information to calculate the proportion of rented paddy land in 1949.

Proportion of Production Loss from Agricultural Disaster (PLAD) This information was acquired from published, monthly data on estimated production loss from agricultural disaster and per-harvest actual production with two modifications. First, I sum up the monthly values of estimated production loss and the per-harvest values of actual production to acquire their annual data. Secondly, I calculate this proportion by dividing the estimated production loss from agricultural disaster by the sum of estimated production loss from agricultural disaster and actual production.

Per-Hectare Amount of Government Supplied Chemical Fertilizer (GSCF) This information was acquired from published, per-harvest data on government supplied chemical fertilizer and the cultivated area of rice with three modifications. First, because the data for 1950 were reported according to the old county system, I match the current units with the corresponding old units³⁸. Secondly, I add up these per-harvest data to acquire annual information. Finally, by dividing this annual information by the corresponding annual cultivated area of rice, I acquire the information on the per-hectare amount of government

³⁸ Beginning in 1951 the published data has been reported according to the current county system. Therefore, I do not need to modify the data beginning in 1951.

supplied chemical fertilizer.

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Table 1. Timeline of Important Events

Year	Events
1945	World War II ended, and the Chinese Nationalist government took over Taiwan.
1949	The tenancy reform program was implemented.
1953	The land transfer program [the Land-to-the-Tiller Program (LTTP)] was implemented.
1962	Tenants who acquired land paid back the full mortgage.

Table 2. Evolution of Tenancy Contracts**(1). Prior 1949: Unregulated Tenancy System**

Contract form	Fixed-rental
Rental fee	Around 50% of the expected paddy land harvest.
Limited liability	In years of poor harvest, tenants were entitled to negotiate to reduce the rental fee.
Contract Duration	The most popular contract duration was 3-5 years.
Security of Tenure	<ol style="list-style-type: none"> 1. If one party canceled the contract before it expired without proper reasons, the other party was entitled to compensation. 2. Landlords could cancel the contracts if their tenants delayed their rental payments without proper reasons or left the land uncultivated. 3. If none of the parties proposed to terminate the contract six months before it expired, this contract would be automatically renewed, although tenants might fail to renew the contracts under certain circumstances.

(2) 1949-52: Regulated by the Tenancy Reform Program in 1949

Contract form	Fixed-rental
Rental fee	The rental fee was stipulated not to exceed 37.5 % of the expected paddy land harvest.
Limited liability	In years of poor harvest, tenants could petition the local government to reduce the rental fee. After receiving the petition, the local government would investigate the extent of damage and then determine the amount of reduction. If the damage was so severe that the actual harvest was less than 30% of the expected amount, the rental fee would be totally waived.
Contract Duration	The contract duration was stipulated to six years.
Security of Tenure	When the contract expired, incumbent tenants could reserve the right to renew it. Landlords could not reject tenants' renewal requests unless three requirements were fulfilled—repossessed land had to be self-cultivated; repossession of the land had to be essential to the landlord's income; and this action was not allowed to cripple the tenant's standard of living.

(3). After the LTTP in 1953

For tenants who did not acquire land, their tenancy contracts were regulated by the 1949 tenancy reform program (as discussed in the second panel). In what follows, I illustrate the contract parameters facing the tenants who acquired land.

Contract form	Ownership
Mortgage payment	Tenants who acquired land paid the price of land through a ten-year, twenty-installment plan. The annual mortgage payment was about 30% of the expected paddy land harvest.
Mortgage Liability	In years of poor harvest, the mortgage could be postponed but it had to be made up in subsequent years so that the full amount of mortgage could not be reduced.
Penalty	If the mortgage payment was delayed for four months, the land would be repossessed by the government.
Leaseability	The acquired land was not allowed to be leased out. If tenants who acquired land were unable to cultivate the land on their own, they could petition the government to purchase the land.
Transferability	Before the full mortgage was paid back in 1962, the acquired land was not transferable and could not be used as collateral for loans before 1962.

Table 3: County-Level Characteristics During 1950 and 1952¹

Variable	All Counties (N=20)		Urban Counties (N=5)		Rural Counties (N=15)	
	Mean ²	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Area (km ²)	1,786	1,334	130	43	2,338	1,053
% of Cultivated Land	33.5	19.9	42.6	17.4	30.4	20.3
% of Paddy Land	21.8	15.5	28.5	14.4	19.6	15.6
Population (person)	382,272	170,276	265,128	133,670	421,319	166,462
Household No. (hh)	69,351	28,706	56,755	29,970	73,550	28,038
Population Density (person/km ²)	837	1,631	2,650	2,659	233	163
Household Size (person/hh)	5.4	0.6	4.7	0.5	5.7	0.3
% of Illiteracy	42.2	9.9	33.5	12.2	45.1	7.3
% of Agricultural Population	33.2	17.7	8.3	5.5	41.4	11.1
No. of Sub-Units	18	8	8	2	21	7
No. of Farmer Associations	16	9	6	2	19	8
Prevalence of Farmer Associations ³ (%)	84.5	14.1	70.4	16.9	89.3	9.7
No. of Farmer Families (family)	33,759	23,502	5,535	3,103	43,167	19,172
Composition of Farmer Family						
% of Owner-Cultivator	36.8	11.1	35.4	21.0	37.2	6.4
% of Part-Owner	21.8	7.7	14.5	3.4	24.2	7.2
% of Tenant	41.5	15.1	50.1	24.3	38.6	10.3

1. Data Source: Taiwan Demographic Yearbook (1959), Annual Report of Farmer Associations in Taiwan (1953), and the Taiwan Agricultural Yearbook (1951-1953).

2. These reported values are average values between 1950 and 1952, with the exception of area, no. of sub-units, and farmer associations. The data on area and no. of sub-units remained the same over time, and the data on farmer associations are only from 1952.

3. Prevalence of the number of farmer associations among sub-units.

Table 4: Characteristics of Owner-Cultivator and Tenant, Rice Cropping Farmer Families Between 1950 and 1951¹

Variable	Owner-Cultivator		Tenant		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Err
Family Size (person)	10.1	3.6	9.2	3.9	0.9	0.6
Persons Able to Work (person)	3.6	1.3	3.7	1.5	-0.1	0.2
Operational Farm Size (chia)	2.2	1.2	1.9	1.2	0.3	0.2
Net Wealth (NT\$) ²	43,468	25,789	13,705	12,605	29,764	3,083
Annual Income						
Per-Capita Income ³ (NT\$)	1,743	641	1,732	691	11	98
Total Income (NT\$)	16,909	7,675	14,659	615	2,250	1,039
Agricultural Income (NT\$)	15,030	7,340	13,265	6,318	1,765	1,020
Annual Expense						
Total Expense (NT\$)	6,135	3,580	6,606	3,419	-471	519
Agricultural Expense (NT\$)	5,990	3,557	6,566	3,397	-576	516
Annual Profit						
Total Profit (NT\$)	10,738	4,681	8,053	3,413	2,685	614
Agricultural Profit (Per-Chia)	4,716	2,105	3,871	2,039	845	307
Per-Capita Profit (NT\$)	1,104	394	942	353	162	56
Profit (Per Person Able to Work)	3,204	1,242	2,363	980	841	167
Sample Size	84		100			

1. Data Source: Agricultural Basic Survey: Report of Investigation on Farm Economy for Rice and Miscellaneous Cropping Farm Family (1952). This survey was conducted only in the 15 rural counties.

2. Between 1950 and 1951, the exchange rate of the NT dollar to the US dollar was 40.

3. The ballpark figure of the 1951 per-capita income amounted to NT\$1,554.

Table 5: Characteristics of Rural Credit in 1949

1. Source of Demand for Credit						
Category	Fixed Capital	Working Capital	Consumpt Credit	Mortgage	Wage Payment	Tax Payment and Others
Percentage	19.5	17.5	33.6	14.7	6.1	8.6
2. Loan Size (NT\$)						
	All Farmers		Owner-Cultivators		Tenants	
	205		207		186	
3. Types of Credit Providers						
	Owner-Cultivator		Tenants			
Institutional Lender (%)	17.4		13.9			
Landlord (%)	1.5		5.5			
Local Lender (%)	4.9		8.0			
Personal Network (%)	76.2		72.6			

1. Data Source: Agricultural Basic Survey: Report on Investigation of Agricultural Finance (1950)
2. This survey was conducted only in the 15 rural counties and 2 urban counties.
3. This survey was conducted in a 7-month period, from June 1, 1949 to Dec. 31 1949. Therefore, the loan size refers to the amount of credit that a farmer family borrowed in this 7-month period.
4. To understand the importance of rural credit, I compare the loan size with the 1949 annual income of farmer families, whose information was not available. Therefore, to obtain a ballpark figure of this information, I deflate the data on the 1951 annual income of owner-cultivator and tenant families by the corresponding wholesale price index. By this way, the 1949 annual income of owner-cultivators amounted to NT\$ 2,528. For tenants, this annual income amounted to NT\$ 2,220.
5. Fixed capital refers to the credit used to purchase livestock and farm machines.
6. Working capital refers to the credit used to purchase seeds and fertilizers.
7. Consumption credit refers to the credit used to purchase daily necessities and to finance consumption needs caused by illness and festivities.
8. Mortgage refers to the credit used to purchase land, improve land quality, and repair houses.
9. Institutional lenders include the Land Bank, the Cooperative Bank, farmer associations, and commercial banks.
10. Local lenders include rice, sugar, and hog merchants and other companies.
11. Personal network includes relatives, friends, and rosca.

Table 6: Data Source (To Be Revised)

Variable	Related Data				
	Name	Period	Coverage Unit	Frequency	Source
Q_{ct}	Rice Yield; Cultivated Area of Rice	1947-49	District-level	Per-Harvest	Taiwan Food Statistics Book (1948-50)
		1950-62	County-level	Per-Harvest	Taiwan Agricultural Yearbook (1951-63)

Variable	Related Data				
	Name	Period	Coverage Unit	Frequency	Source
TPL_{c53}	Area of Paddy Land	1953	County-level	Annual	Taiwan Agricultural Yearbook (1954)
	Area of Transferred Paddy Land in the LTTP	1953	County-level	Annual	Land Reform Initiative in Taiwan (1954)

Variable	Related Data				
	Name	Period	Coverage Unit	Frequency	Source
RPL_{c49}	Operation of Paddy Land	1949	District-level	Annual	Report of Investigation on Ownership and Operation of Arable Land (1950)

Variable	Related Data				
	Name	Period	Coverage Unit	Frequency	Source
CF_{ct}	Regulated Supply of Chemical Fertilizer	1947-1948 1 st harvest	Nationwide	Per-Harvest	Taiwan Food Statistics Book (1952)
		1948 2 nd harvest-1950	County-level	Per-Harvest	Taiwan Food Statistics Book (1955)
		1951-1962	County-level	Per-Harvest	Taiwan Food Statistics Book (1955-63)
	Cultivated Area of Rice	1947-62	County-level	Per-Harvest	Taiwan Agricultural Yearbook (1948-63)

Table 7: Summary Statistics of TPL, Rice Yield, and Proportion of Production Loss from Agricultural Disaster

Variable	Northern Counties		Southern Counties		Difference	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Error
Proportion of Transferred Paddy Land in 1953	0.37	0.13	0.24	0.2	0.13	0.02
Rice Yield (kg/ha)						
1950-52	1821	411	1812	413	9	56
1953-55	1942	513	2085	496	-143	66
1954-56	2002	508	2129	517	-127	67
1950	1784	406	1740	404	43	53
1951	1771	448	1815	401	-43	56
1952	1909	480	1881	465	28	62
1953	1981	509	2037	467	-56	64
1954	1911	588	2119	550	-208	75
1955	1935	506	2099	526	-165	67
1956	2159	480	2168	532	-9	65
Proportion of Production Loss from Agricultural Disaster (PLAD)						
1950-52	0.033	0.025	0.041	0.030	-0.008	0.014
1953-55	0.138	0.054	0.063	0.027	0.075	0.024
1954-56	0.132	0.041	0.060	0.023	0.072	0.018
1950	0.020	0.026	0.022	0.026	-0.002	0.014
1951	0.053	0.049	0.059	0.054	-0.006	0.027
1952	0.026	0.027	0.043	0.044	-0.017	0.018
1953	0.094	0.050	0.103	0.060	-0.009	0.029
1954	0.182	0.119	0.042	0.025	0.140	0.049
1955	0.139	0.072	0.045	0.025	0.094	0.031
1956	0.074	0.085	0.093	0.053	-0.019	0.039

1. The information on TPL and rice yields is taken from township-level data. For northern and southern counties, the sample size is 95 and 156, respectively.

2. The information on PLAD is taken from county-level data. For northern and southern counties, the sample size is 6 and 9, respectively.

Table 8: Summary Statistics of the 15 Rural Counties

Variable	County-Level Data (N=15)				Township-Level Data (N=251)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Proportion of Rented Land in 1949	0.59	0.13	0.38	0.78	0.57	0.18	0.07	0.94
Proportion of Transferred Paddy Land (TPL) in the LTTP in 1953								
Source: Land Bureau	0.27	0.13	0.10	0.49	N/A			
Police Department	0.30	0.16	0.10	0.63	0.29	0.19	0.01	0.81
Rice Yield (kg/ha)								
1950-52	1,850	258	1,481	2,288	1,816	423	778	2,724
1953-55	2,073	305	1,700	2,544	2,031	506	790	3,180
Production Loss From Agricultural Disaster (PLAD)								
1950-52	0.038	0.027	0.009	0.083				
1953-55	0.093	0.054	0.027	0.188				
Government Supplied Chemical Fertilizer (kg/ha)								
1950-52	348	53	264	444				
1953-55	507	158	273	785				
Mean Temperature* (0.1C)								
1950-52	231	16	194	251				
1953-55	232	16	195	253				
Annual Rainfall (0.1mm)								
1950-52	22,658	4,472	16,262	31,438				
1953-55	20,996	4,325	14,431	29,421				

*The information on mean temperature and annual rainfall is acquired from 12 weather stations that cover the whole area of the 15 rural counties.

Table 9: OLS in First Difference Estimates
Dependent Variable.: Increase of Rice Yield b/w 1950-52 and 1953-55

Explanatory Variables	A	B	C	D	E	F	G	H	I	J
	1. County-Level Analysis					2. Township-Level Analysis				
Transferred Paddy Land in the LTTP in 1953 (TPL)	0.31 (0.08)	-0.22 (0.09)	-0.11 (0.09)	-0.09 (0.08)	-0.10 (0.10)	0.26 (0.02)	-0.09 (0.04)	-0.01 (0.05)	-0.04 (0.03)	-0.03 (0.03)
Increase of Loss from Agricultural Disaster b/w 1950-52 and 1953-55			-0.44 (0.19)	-0.49 (0.18)	-0.56 (0.26)			-0.85 (0.14)	-0.85 (0.14)	-0.99 (0.22)
Increase of Gov't Supplied Chemical Fertilizer b/w 1950-52 and 1953-55				0.07 (0.04)	0.06 (0.07)				0.11 (0.04)	0.12 (0.03)
Increase of Temperature b/w 1952 and 1953-55					1.14 (2.99)					2.56 (2.83)
Increase of Rainfall b/w 1952 and 1953-55					-0.09 (0.33)					0.03 (0.19)
Intercept		0.17 (0.03)	0.17 (0.02)	0.14 (0.03)	0.14 (0.03)		0.13 (0.01)	0.15 (0.02)	0.12 (0.02)	0.11 (0.02)
R ²	0.55	0.33	0.54	0.62	0.63	0.34	0.03	0.26	0.32	0.33
Sample Size	15	15	15	15	15	233	233	233	233	233

1. To facilitate the comparison with township-level results, the county-level observations include 15 rural counties only.
2. For county-level analysis, the information on TPL is taken from the land bureau.
3. Since the two TPL measures diverge in Pengtung Hsien, the township-level observations exclude the townships in Pengtung Hsien but include 233 townships in the other 14 rural counties.
4. For township-level analysis, although the data on rice yield and TPL are at the township-level, the data on weather, production loss from agricultural disaster, and government supplied chemical fertilizer are at the county-level because for these variables township-level data are not available. Therefore, in Column H-J I specify that the observations are independent across counties but not necessarily independent within counties and hence implement the cluster option with regression commands in Stata.
5. Difference in log form for rice yield increase and the covariates of weather and government supplied chemical fertilizer.
6. In parentheses are standard errors.

Table 10: Sensitivity Analysis
Dependent Variable: Increase of Rice Yield b/w 1950-52 and 1953-55

Explanatory Variables	A	B	C	D	E
Transferred Paddy Land in the LTTP in 1953 (TPL)	0.04 (0.08)	-0.12 (0.10)	0.06 (0.07)	0.03 (0.06)	-0.02 (0.04)
Increase of Loss from Agricultural Disaster b/w 1950-52 and 1953-55	-0.69 (0.27)	-0.43 (0.27)	-0.92 (0.25)	-0.61 (0.01)	-1.53 (0.10)
Increase of Gov't Supplied Chemical Fertilizer b/w 1950-52 and 1953-55	0.10 (0.07)	0.07 (0.05)	0.12 (0.03)	0.08 (0.02)	0.13 (0.01)
Increase of Temperature b/w 1952 and 1953-55	1.10 (3.14)	-0.62 (3.04)	0.76 (3.51)	1.50 (0.53)	5.85 (1.01)
Increase of Rainfall b/w 1952 and 1953-55	0.10 (0.34)	-0.16 (0.30)	0.21 (0.24)	0.20 (0.12)	-0.23 (0.07)
Urban Dummy		0.06 (0.07)			
Interaction b/w TPL and Urban Dummy		-0.36 (0.24)			
Intercept	0.11 (0.03)	0.14 (0.03)	0.11 (0.02)	0.08 (0.01)	0.10 (0.01)
R ²	0.60	0.61	0.29	0.30	0.30
Sample Size	15	20	251	95	138

1. Column A includes 15 rural counties; Column B includes all counties; Column C includes all townships in the rural counties; Column D includes townships in the northern counties; Column E includes townships in the southern counties but exclude Pengtung Hsien.
2. In Column A, the county-level TPL information is taken from the police department.
3. Difference in log form for rice yield increase and the covariates of weather and government supplied chemical fertilizer.
4. In parentheses are standard errors.

Table 11: Sensitivity Analysis

Explanatory Variables	A	B	C	D	E
<u>1. IV in First Difference Estimates</u>					
Dependent Vari.: Increase of Rice Yield b/w 1950-52 and 1953-55					
1st Stage Estimate of TPL data from the police department	0.56 (0.15)				
1st Stage Estimate of Rented Paddy Land in 1949		1.04 (0.07)	0.42 (0.05)		
2nd Stage Estimates					
Transferred Paddy Land in the LTTP in 1953 (TPL)	0.08 (0.13)	-0.09 (0.08)	-0.08 (0.08)		
Increase of Loss from Agricultural Disaster b/w 1950-52 and 1953-55	-0.70 (0.24)	-0.57 (0.20)	-0.97 (0.21)		
Increase of Gov't Supplied Chemical Fertilizer b/w 1950-52 and 1953-55	0.10 (0.06)	0.06 (0.05)	0.12 (0.03)		
Increase of Temperature b/w 1952 and 1953-55	0.76 (2.74)	1.11 (2.32)	2.79 (2.67)		
Increase of Rainfall b/w 1952 and 1953-55	0.13 (0.32)	-0.08 (0.26)	-0.03 (0.20)		
Intercept	0.10 (0.03)	0.13 (0.02)	0.12 (0.02)	0.19 (0.05)	0.14 (0.04)
Sample Size	15	15	233	15	233

1. Column A and D include 15 rural counties; Column C and E include all townships except townships in Pengtung Hsien.

2. In Column A-C, the instrumented variables are the TPL data from the land bureau, the land bureau, and the police department, respectively; the instrumental variables are the TPL data from the police department, RPL, and RPL, respectively.

3. Difference in log form for rice yield increase and the covariates of weather and government supplied chemical fertilizer.

4. In parentheses are standard errors.

Figure 1: The Composition of Farmer Families in Taiwan

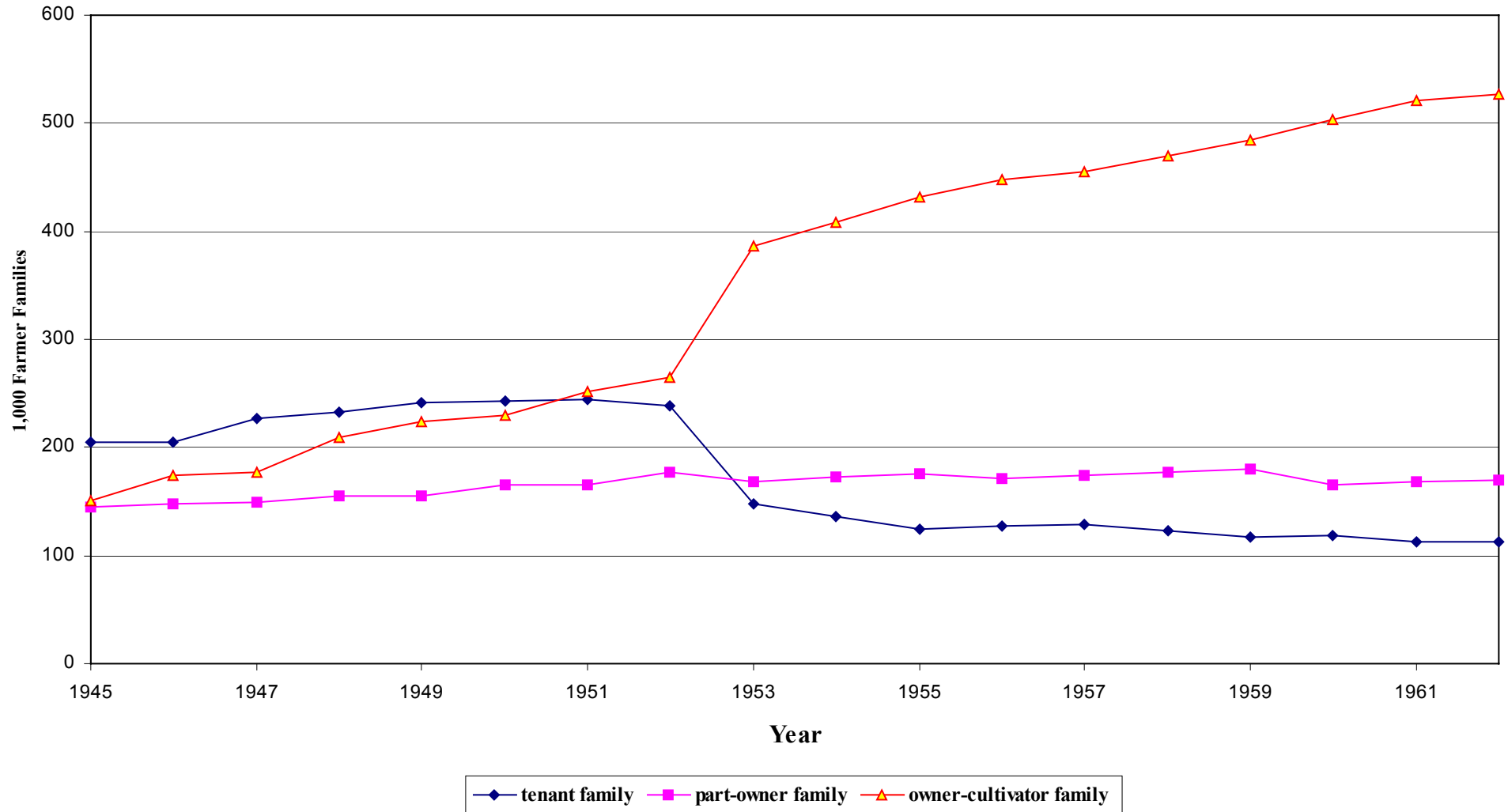


Figure 2: Differences between the Two TPL Data Sources

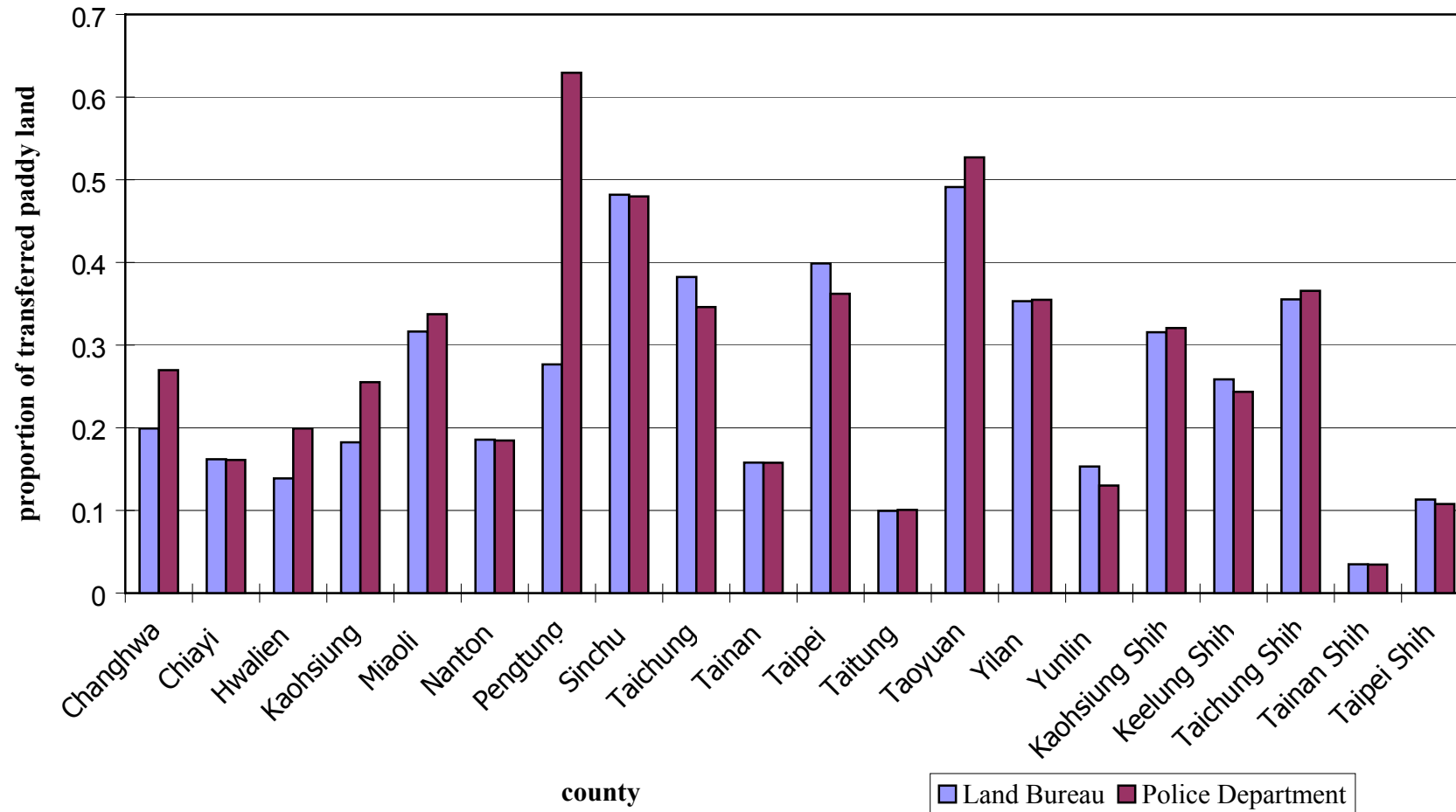


Figure 3: The Trend of Rice Yield

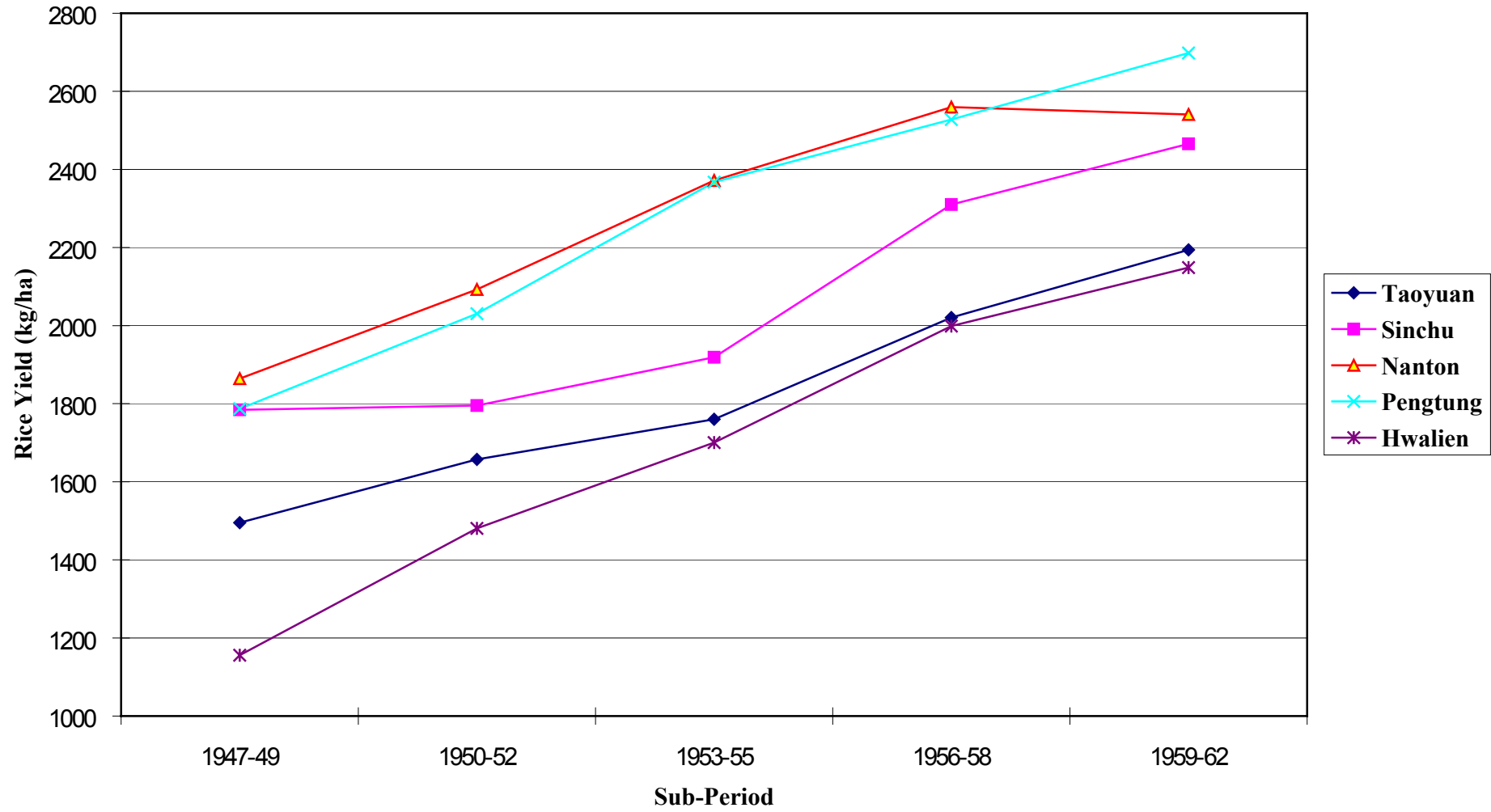


Figure 4: The Relation b/w the Increase of Rice Yield b/w 1950-52 and 1953-55 and the Proportion of Transferred Paddy Land in the LTTP in 1953

