Wage Growth, Landholding and Mechanization in Agriculture

Evidence from Indonesia[1]

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Abstract

This paper examines dynamic patterns of land use, capital investments and wages in agriculture using farm panel data from Indonesia. The empirical analysis shows that with an increase in real wages that prevailed in both agricultural and non-agricultural sectors in rural areas, relatively larger farmers increased the size of operational farm land by renting in land. An increase in real wages has induced the substitution of labor by machines among relatively large farmers. Machines and land are complementary and, consistently, the inverse land-productivity relationship is reversed among relatively large holders.

Key words: Wage growth, farm size, mechanization, Indonesia

JEL Classifications: J31, Q12, Q15

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1.Introduction

It has been increasingly recognized that rapidly-growing Asia is becoming a driving force of economic growth in the world but also a growing concern in the global food economy due to its large share of grain imports in the world.[3] Economic growth, urbanization and transformation of the economic structure in Asia have been the fastest in the world, which has induced increasing real wages not only in urban and non-agricultural sectors but also in many parts of rural and agricultural sectors in Asia. Although the above transformation contributed to reducing poverty in the region, it also created a challenge to farming which depends on small-scale and family based operations. In this paper, I examine whether an increase in real wage induces a realization of scale economies and investments in machines that substitute for labor, using farm panel data from Indonesia.

Family labor tends to be more intensively used on smaller farms in the absence of efficient labor markets, which, in turn contributes to the inverse relationship between farm size and crop yield (Feder 1985; Berry and Cline 1979; Benjamin and Brandt 2002). In fact, Asian agriculture has been dominated by labor-intensive small farms mainly relying on family labor. However, such an inverse relationship could be altered with fast economic growth, often accompanying a rising wage rate, because labor-intensive production becomes costly. The wage growth may have significant effects on the efficiency of small-scale farming in Asia and potentially more generally in developing countries.[4]

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[3] Low self-sufficiency is evident in Japan, Korea, Taiwan and more recently becoming a serious concern in China, where imports of certain commodities increased very rapidly. Though exporters such as Thailand, Brazil, and Argentina can enjoy such a trend, it is possible that the above trend observed in Asia will destabilize the supply-demand balance in the global food economy.

[4] Useful insights also come from the history of agricultural development. The British enclosure movement during its industrial revolution played a role in consolidating farm lands to thus suppress wages and release labor to non-agricultural industries. Labor cost and supply in the labor market could be critically linked to landownership and land consolidations in rural areas. As Hayashi and Prescott (2006) recently illustrated in a calibration model, the family system that governs land inheritance (which happened to maintain the dominance of small farms) could have reduced the supply of labor to non-agricultural sectors, which thus substantially reduced the potential of industrial growth in prewar Japan.

The following intuition shapes up the key hypothesis. An increase in real wages increases the production cost of labor-intensive farming system and thereby decreases comparative advantage in agriculture based on the labor-intensive production methods widely observed in many parts of Asia. To restore comparative advantage, at least partially, farm size expansion and large-scale mechanization must take place so as to save high-cost labor. However, the introduction of large-scale mechanization is difficult if farm size is constrained by some factors, such as total land endowment, population density and a relatively high value of non-agricultural land use, which all prevail in Java. All the above factors generate an advantage to large farmers. If expansion of farm size is easy for larger farmers, it may create a divergence in production efficiency and profitability between large and small farmers.

This paper shows evidence from Indonesia to support the proposition that wage growth in recent years led to an introduction of labor saving practices among relatively large farmers. That is, larger farmers tend to acquire more land by renting in land and install machines if real wages increase. The empirical findings also show that land and machines are complementary among relatively large landholders. The above trend also divides the dynamics of farm production between Java and off-Java as land endowments are relatively large outside Java and small landholders are concentrated in Java.

As Otsuka (2013) elaborates in his paper, increasing real wages (and transformation of occupational structures in labor markets) challenge Asian agriculture in which the majority of farmers are smallholders, because of the increasing need (i) to reduce the labor force in agriculture (as the opportunity cost of farming increases), (ii) to increase the average farm size (to reduce labor use by introducing labor-saving production methods) and (iii) to generate enough income to retain parity with non-agricultural workers. If land markets and/or institutional mechanisms are imperfect, major inefficiencies in the allocation of farm land will be bound to arise. Otsuka, Liu and Yamauchi (2013) present evidence consistent with the above conjectures using cross-country panel data. Foster and Rosenzweig (2010, 2011) also show some evidence to support the second point in India.

The key idea of this paper is related to an important line of thought in the literature. Developing the concept of induced innovations proposed by Hicks (1932), Hayami and Ruttan (1985) introduced the idea of induced institutional changes in agriculture. An increase in real wages may induce a technical change to save labor, i.e., mechanization, but also could lead to an institutional arrangement that saves labor and/or reduces user costs of machines on farm even without land consolidation. For example, if machines can be rented relatively cheaply, even small farmers may be able to effectively save labor by utilizing machines through rental markets.[5] In this context, I examine whether changes in relative factor prices altered productivity through labor-capital substitutability potentially constrained by the initial land distribution. But it remains possible that (i) land reallocation could happen through land rental markets and (ii) institutional arrangements such as emergence of machine rentals can facilitate the substitution of labor by machines.[6]

Indonesia provides an interesting setting in which relatively abundant and scarce land endowments coexist. Land is immobile across islands, while labor is mobile. Demarcation between macro-regional islands offers us an ideal experimental ground, when real wages rise, to learn about differences in the consequence of wage growth between relatively land-abundant and land-scarce regions.[7]

The paper is organized as follows. Section 2 describes empirical strategy. Section 3 on the panel data collected in 7 provinces in Indonesia. The empirical findings are summarized in Section 4, followed by concluding remarks.

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[5] This will be the case in some areas, e.g., lowland agriculture. However, it is more difficult in hilly areas including terraced rice production.

[6] See Wang, et al. (2014) for a Chinese case study.

[7] Indonesia has traditional harvest arrangements by traders who purchase products before harvest time (reducing price risk to farmers), or bring labor to farm yards to harvest, called Ijon and Tebasan respectively. Casual observation in the field suggest that machines are rarely brought to harvest in the practice of Tebasan concentrated in Java, which implies that an increase in labor costs has not been too high, i.e., there are still sufficient low-cost laborers available to farming. However, the empirical findings of this paper also point to the emerging phenomenon of large farmers outside Java having started scaling up their operations with mechanization. Therefore, it appears that Indonesian farming is reaching a cross-road, potentially resulting in divergences in efficiency across differently endowed regions.

2. Empirical Strategy

This section describes specifications and estimation strategy used in the analysis. Land transactions and machine investments are analyzed in the following first-differenced equation,

$$\Delta y_{ij(0,1)} = \alpha + \beta_1 \Delta w_{j(0,1)} + \beta_2 \Delta w_{j(0,1)} land_{ij0} + x_{ij0}'\delta + province_{ij} + \Delta\varepsilon_{ij(0,1)} \qquad (1)$$

where $\Delta y_{ij(0,1)}$ is change in self-cultivated land or rent-in land,[8] or the value of machine investments for household i in village j, from time 0 to 1, $\Delta w_{j(0,1)}$ is the village-level real wage growth rate (agricultural and non-agricultural wages, treated separately) between 2007 and 2010, $land_{ij0}$ is the self-cultivated land size in time 0, x_{ij0} is a vector of initial household characteristics, $province_{ij}$ is a province dummy, and $\Delta\varepsilon_{ij(0,1)}$ is the difference in shocks (assume that ε_{ijt} is an ex-post shock after household decisions are made).

Note that β_1 is the effect of change in the village-level real wage rate on the dependent variable, and β_2 captures how the initial land-holding affects the impact of change in the village-level real wage rate. The estimated village-level real wage growth rate is interacted with the initial self-cultivated land size. We hypothesize that $\beta_2 > 0$. That is, facing rising real wages, relatively large holders tend to increase their operational size and invest in machines.

The crop income equation is also estimated in the first differenced form:

$$\Delta \ln \pi_{ij(0,1)} = \phi + \gamma_1 \Delta land_{j(0,1)} + \gamma_2 \Delta mach_{ij0} + \gamma_3 \Delta land_{j(0,1)} \Delta mach_{j(0,1)} + village_{ij} + \Delta\eta_{ij(0,1)} \qquad (2)$$

[8] The survey data used in this paper do not have information on rented-out land, so it is possible here to focus only on rented-in land.

where $\Delta\ln\pi_{ij(0,1)}$ is the crop income growth (that is, the difference in log of crop income between time 1 and 0), $\Delta land_{j(0,1)}$ is change in the self-cultivated land, $\Delta mach_{ij0}$ is machine investment or change in machine services purchased, $village_{ij}$ is village fixed effects, and $\Delta\eta_{ij(0,1)}$ is the difference in ex-post shocks. The variable $\Delta land_{j(0,1)}$ can be decomposed into changes in owned land and rent-in land. Our interest is in the parameter γ_3 measuring the complementarity between land and machines ($\gamma_3 > 0$) especially among relatively large holders.

$$\Delta\ln\pi^*_{ij(0,1)} = \phi' + \gamma'_1\,\Delta land_{j(0,1)} + \gamma'_3\,\Delta land_{j(0,1)} land_{j,0} + village_{ij} + \Delta\eta_{ij(0,1)} \qquad (3)$$

To investigate (in a reduced form) the relationship between crop productivity and farm size, per-ha crop income growth $\Delta\ln\pi^*_{ij(0,1)}$ (crop income normalized by the self-cultivating land size) is regressed on change in self-cultivated land size and its interaction with the initial land size. Eq (3) examines whether the effect of change in land size (say, by renting in land) can differ by the initial land size. Through the complementarity between land and machines, the marginal effect of farm size may change by the initial land size ($\gamma'_3 > 0$) as relatively larger holders can find it easier to introduce machines that improve land productivity.

3. Data

3.1 Household Survey

The data come from two rounds of household survey conducted in rural areas of Indonesia. The primary source of our data is the village and household level surveys that we conducted in 2007 and 2010 for 98 villages in seven provinces (Lampung, Central Java, East Java, West Nusa Tenggara, South

Sulawesi, North Sulawesi, and South Kalimantan) under the Japan Bank for International Cooperation (JBIC) Study of Effects of Infrastructure on the Millennium Development Goals in Indonesia (IMDG). Figure 1 shows the locations of surveyed villages. In 2010, we revisited all of the 98 sample villages to re-interview sample households and their splits after the 2007 survey. Out-migrants were tracked through either direct or phone interviews.

Figure 1 to be inserted

The 2007 survey was designed to overlap with villages in the 1994/95 PATANAS survey sample. The 1994/95 PATANAS survey is representative for the major agro-climatic zones in the country, with a focus on agricultural production activities, so the 2007 survey is also representative in the above sense. The sample also included households in fishery villages and laborer households. In 2007, we visited those villages to expand the scope of research as a general household survey under the IMDG survey (see Yamauchi et al. 2011)

In the 2007 round, we also added 51 new villages in the same seven provinces. These new villages were selected using the following criteria. First we chose the same districts where PATANAS villages are located. We listed villages that had received relatively large amounts of government infrastructure projects during the period 1995 to 2005, funded by either the Japan Bank for International Cooperation or the World Bank. Finally, the new villages were randomly sampled from the list.

In the revisited villages in 2007, we re-sampled 20 households per village from the 1994/95 sample (using a proportional sampling based on landholding size) and followed the split households. In the new villages, we sampled 24 households from two main hamlets in each village. Since one of the 48 villages in the 1994/95 PATANAS was not accessible for safety reasons in the 2007 survey (in West Nusa

Tenggara province), we have the total of 98 villages that are available for various research objectives. (The 2010 survey followed sample households and their split households in all 98 villages).[9]

Some household members split from the 2007 original households to start their new households or to join other households. In the household-level panel analysis, for households that split between the two rounds of data collection in 2007 and 2010, incomes of original household and split households are aggregated by using the 2007 household unit as the base in the following way. The analysis includes new households if an original household member became a new household head and lives *in the same village* (called split households). Household members who moved outside the original village or joined other households within the village (both called out-migrants) are excluded from our analysis.[10] Then, incomes are aggregated from both original and split households in 2010 to be comparable with the 2007 original households.[11]

3.2 Agricultural Production, Landholding and Machines

Agricultural production was recorded with detailed information but rather differently in the two rounds. In 2007, the survey collected information on outputs and inputs for each crop by crop season, using management units defined by irrigated and un-irrigated lands. The 2010 survey collected plot-level information for each crop and crop season. In the analysis, I use crop income deducting input costs, i.e., crop profit before including family labor costs.

Machine investments in the period of 2007 to 2010 were captured in the 2010 survey. The analysis uses total values of investment such as tractors, threshers, etc., which function to substitute for farm labor.

[9] Examples of works using the 2007-2010 panel data include Yamauchi (2013), which looks at the impact of increased transportation speed on labor supply and wages. Seasonality of birth weights and its impacts on human capital formation are analyzed by using the 2007 survey data (Yamauchi, 2012).
[10] Potential attrition-related bias in the current analysis is small since the dynamics of crop income is its focus, not household income in general, which includes non-agricultural employment and remittance incomes.
[11] The food price crisis of 2008-10 may be correlated with split (and migration) decisions, which raises an additional concern that supports the aggregation of incomes from the 2007 original household and its splits in the period 2007 – 2010.

Land is aggregated at the household level, but categorized into three types: self-cultivated own land, self-cultivated rented-in land and rented-out land. The analysis focuses on self-cultivated own land and self-cultivated rented-in land as the farm cultivation decision is the main issue of this paper. Whether owned or rented-in does not matter in the analysis.[12]

Table 1 to be inserted

Table 1 shows the average farm size (self-cultivated own and rented-in) for the whole sample as well as for each province. The second column shows the average land size in the sample of farmers who had non-negative crop incomes in both years. It is clear in the table that farm size is smaller in the Java provinces than outside Java. The average farm size is extremely small, i.e., less than 0.5 ha, in the Java provinces (Column 2), in contrast to outer-Java islands where the average farm size is above 1 ha.[13] By using the sample of farmers who had non-negative crop incomes in both sample years, the average size increases marginally, except for North Sulawesi in our sample.

3.3 Labor Markets and Wages

Village-level wages for both agricultural and non-agricultural works are estimated from individual-level employment data in 2007 and 2010. Both rounds used the identical module to record job type, wage rate, number of days worked, duration, contract type, etc. for each individual employment experience in the past year. Individual frequently had several employment spells in the previous year and this method was applied to both agricultural and non-agricultural employment.

The data processing followed a few steps. First, we computed the daily wage for agriculture and the monthly wage for non-agricultural work at the individual level. Second, the distribution of the household-level average wages was obtained. Third, we compared the average wages at the village level – both

[12] Since rent-out land is not recorded in the survey, the analysis uses only rent-in land (not net rent-in).
[13] In addition to the observed difference in farm size, it is possible that soil quality significantly differs between Java and non-Java islands.

agriculture and non-agriculture – between 2007 and 2010. The analysis uses growth rate of the village-average wages by sector.

Table 2 to be inserted

Table 2 shows the sample averages of real non-agricultural and agricultural wage growth. Except for agricultural wage in South Sulawesi and both wages in Central Java, real wages increased substantially over 3 years. In Lampung, East Java, South Kalimantan, and North Sulawesi, real agricultural wages increased faster than real non-agricultural wages.

3.4 Farm Size and Land Rental Transactions

Simple observations are presented on (i) wage growth and land transactions and (ii) productivity change, both of which motivate the analysis below. First, Figure 2 shows the relationship between change in rent-in land and the initial size of self-cultivated land under two different conditions: high and low wage growth areas.[14] For the relationship between change in rent-in land and the initial operational land size, the conventional wisdom is that tenants are likely to be small holders.

Figure 2 to be inserted

In contrast to this view, the figure shows that (i) very small holders did not change their rent-in behavior, (ii) for about 4 to 7 ha, farmers tend to reduce the rented-in land, and (iii) from 7 to 10 ha, they tend to rent in more land especially in villages where real wages are rising rapidly. More land is rented from medium holders to large holders in villages where real wages are rising fast.

4. Empirical Results

[14] The sample of villages is split into two groups: (i) real non-agricultural wage growth rate was above 20%, and (ii) less than 20%. Note that the average growth rate is around 20%.

This section summarizes the empirical results. Table 3 shows the results on self-cultivated land using the full sample. Columns 2 and 3 include interaction terms of real wage growth with the initial self-cultivated land size and log of the initial size, respectively. In Column 1, agricultural wage growth significantly increases the size of self-cultivated land. In Column 2, the above result remains robust. Real non-agricultural wage growth increases the self-cultivated land size, but it is statistically insignificant. With log of the initial size of self-cultivated land, none of the above is significant. Second, the average age has a significant negative effect, and the number of household members (in age 20 to 55) has a significant positive effect in all the specifications. Column 4 uses a sample of farmers holding larger than 0.6 ha, omitting marginal farmers. Interestingly, the effect of real agricultural wage growth is significantly positive in this group, which is consistent with the previous results.

Tables 3 and 4 to be inserted

Next, Table 4 shows estimation results on change in rent-in land, i.e., not-owned self-cultivated land. The analysis uses the same specifications as in Table 3. In Column 1, rent-in land increases significantly when real non-agricultural wage increases. The introduction of interaction terms of wage growth with the initial self-cultivated land size makes the growth of real agricultural wage significantly positive (Column 2). With interaction terms of wag growth with log of the initial self-cultivated land size, both non-agricultural and agricultural wages show significantly positive effects on change in rent-in land. In contrast to Table 3, the average years of schooling significantly reduces change in rent-in land, which implies that those households endowed with high level of human capital (measured in educational attainment) tend to reduce rent-in land (or rent out). Column 4 again restrict the sample to farmers holding larger than 0.6 ha. The effect of real non-agricultural wage growth is significantly positive in this group. Combined with the previous results in Table 3, it is reasonable to conclude that, when real wages increase, the size of operational farm land tends to expand among relatively larger holders.

Table 5 to be inserted

Table 5 shows results on machine investments.[15] The analysis uses Tobit model to estimate marginal effects. First, the results in Columns 1 and 2 are not appealing but Column 3 shows a significantly positive interaction term of real agricultural wage growth and the initial self-cultivated land size. When agricultural wage increases, relatively large farmers tend to invest in machines. Second, the proportion of female members has a significantly negative effect, which implies gender differences in the tendency in using machines in the field. Third, the initial land size significantly affects the decision to invest in machines most likely due to the liquidity constraint and the possibility of using land as collateral to borrow credit, and/or scale advantage among large holders.

Table 6 to be inserted

Table 6 summarizes the estimation results on crop income and productivity growth. In Columns 1 to 4, the dependent is the growth of crop income (after deducting all costs except family labor) taking the difference in log crop incomes between 2007 and 2010. Thus, negative income observations were dropped from the sample. The first three columns use all farmers with positive crop incomes in both years. Three results emerge. First, self-cultivated land, both owned and rent-in, has significant positive effects on crop income (Column 1). Second, machine investment also has a marginally significant effect on crop income (Column 2). Third, if we include the interaction term between cultivated land and machine investment (Column 3), the effects of land and machine investment remain robust, and the interaction has a positive effect on crop income, but this is marginally insignificant.

Next, Column 4 uses the sample of farmer holding greater than 0.6 ha. Thus, marginal farmers are not included in the analysis. In this group, we find that land acquisition and machine investments are complementary, mutually augmenting crop income. Though the above complementarities are supported, the marginal effects of land and machines become insignificant. That is, a combination of land and

[15] The dependent variable is the total investment value in the period of 2007 to 2010, recorded in the IMDG-2 survey, not calculated from capital stocks from the two survey years.

machines as an investment package is profitable for the group of farmers who have relatively large land endowments.

Finally, Column 5 checks land productivity growth by using a change in log of per-hector crop income from 2007 to 2010. Log transformation, once combined with village fixed effects, makes the analysis unit-free under the assumption that price change is village specific. Given the results in Table 5 (and also Figure 2), an increase in the operational land size is expected to raise productivity only among relatively large farmers. The interaction of change in self-cultivated land and the initial self-cultivated land size in 2007 captures the scale effect. Interestingly, the effect of increased self-cultivated land is significantly positive as the initial land size increases, whereas the linear effect of land size is negative (insignificant). Column 6 restricts the sample to villages where non-agricultural wage growth was higher than the average, 20%. The results show that the positive effect of land size on crop productivity is more significant among relatively large holders when real wages increased fast. The inverse land-productivity relationship tends to be revised among relatively large farmers.

5. Conclusions

This paper showed that an increase in real wages has been inducing relatively large farmers to expand their operational farm land by renting in land and substitute labor by machines. The empirical results also show that machine investments and land are complementary, if marginal farmers are omitted from the analysis. Consistently, crop productivity has increased along with an expansion of operational farm size.

In the context of Indonesia, the above findings can be translated into a divergence in production frontier between Java and outer-Java regions as the majority of small farmers are concentrated in Java. The findings lead to a prediction that agriculture in favorably endowed outer-Java islands can stay on the frontier by promoting mechanization on the basis of the initial scale advantage, while smaller farmers in Java tend to be trapped in high-cost agriculture due to rigidity of land markets.

Historically land reforms in developing countries have typically aimed to create small farmers by redistributing land from landlords to tenants. Successful land reforms contributed to promoting equity as well as efficiency in agriculture but could impose a historical constraint on production efficiency when labor shortage becomes serious. While small farmers find it difficult to maintain family-labor intensive production, it is also politically challenging to re-redistribute land to enlarge operational land sizes, say, through land consolidation programs. In the current empirical setting, land rental market seems to be functioning to support an expansion of operational farm size to some extent.

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Figure 1 Locations of surveyed villages

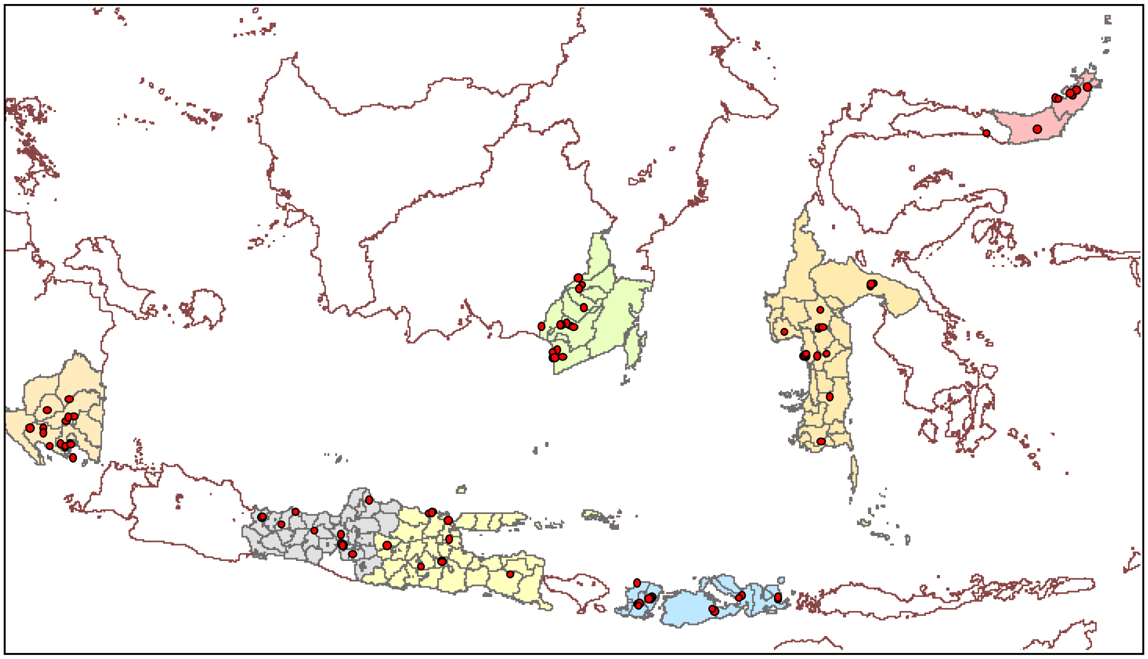

Figure 2 Change in rent in land and the initial landholding: High vs low wage growth villages

Table 1 Average land size (ha) in 2007

		Crop income>0 in2007 and 2010
All sample provinces	1.088 (1.429)	1.170 (1.417)
Lampung	1.324 (1.256)	1.342 (1.213)
Central Java	0.366 (0.448)	0.401 (0.535)
East Java	0.519 (1.499)	0.471 (0.410)
NTB	1.005 (1.125)	1.120 (1.271)
South Kalimantan	1.249 (1.264)	1.267 (1.024)
North Sulawesi	1.626 (2.472)	2.201(2.816)
South Sulawesi	1.063 (1.068)	1.111 (1.098)

Numbers in parentheses are standard deviations.

Table 2 Real wage growth (%)

	Non-agricultural	Agricultural
All sample provinces	18.32	23.13
Lampung	12.46	51.95
Central Java	6.163	5.733
East Java	27.13	40.02
Nusa Tenggara Barat	24.62	14.71
South Kalimantan	14.43	23.91
North Sulawesi	31.22	63.94
South Sulawesi	16.59	-20.70

Provincial CPI is used for the conversion of nominal into real terms.

Table 3 Land transactions: Self-cultivated land

Dependent: Change in self-cultivated land				
Sample:				Land>0.6 ha
Real wage growth: Non-agriculture	0.0547	0.2035	0.0243	0.0286
	(0.91)	(1.89)	(0.40)	(0.37)
Real wage growth: Agriculture	0.0924	0.1335	0.0368	0.1350
	(3.15)	(2.29)	(0.60)	(2.28)
Real wage growth: Non-agriculture * self-cultivated land 2007		-0.2070		
		(1.18)		
Real wage growth: Agriculture * self-cultivated land 2007		-0.1296		
		(1.30)		
Real wage growth: Non-agriculture * log self-cultivated land 2007			-0.1925	
			(1.92)	
Real wage growth: Agriculture * log self-cultivated land 2007			-0.0985	
			(1.13)	
Years of schooling (age 20-55; 2007)	-0.0249	-0.0167	-0.0240	-0.0183
	(1.26)	(0.84)	(1.25)	(0.59)
Age (age 20-55; 2007)	-0.1133	-0.0100	-0.0113	-0.0178
	(2.18)	(2.19)	(2.24)	(1.26)
Female (age 20-55; 2007)	-0.1219	-0.1068	-0.0913	-0.1063
	(0.40)	(0.33)	(0.30)	(0.18)
Number of hh members (age 20-55; 2007)	0.0780	0.0842	0.0882	0.1443
	(1.89)	(1.98)	(2.01)	(3.04)
Positive crop income in 2007	0.0500	0.0680	0.0798	0.0323
	(0.41)	(0.58)	(0.67)	(0.16)
Province fixed effects	yes	yes	yes	yes
R squared (within)	0.0099	0.0348	0.0159	0.0143
Number of observations	1196	1189	1189	643

Numbers in parentheses are absolute t values using robust standard errors with province clusters.

Table 4 Land transactions: Rent-in land (Not-owned self-cultivated land)

Dependent: Change in rent-in land				
Sample:				Land>0.6 ha
Real wage growth: Non-agriculture	0.0891	0.0307	0.1043	0.1101
	(3.58)	(0.72)	(2.81)	(2.48)
Real wage growth: Agriculture	0.0338	0.1152	0.0674	0.0419
	(1.25)	(2.74)	(2.19)	(1.15)
Real wage growth: Non-agriculture * self-cultivated land 2007		0.0841		
		(1.14)		
Real wage growth: Agriculture * self-cultivated land 2007		-0.0646		
		(1.89)		
Real wage growth: Non-agriculture * log self-cultivated land 2007			0.0854	
			(1.28)	
Real wage growth: Agriculture * log self-cultivated land 2007			0.0173	
			(0.42)	
Years of schooling (age 20-55; 2007)	-0.0276	-0.0263	-0.0281	-0.0495
	(2.71)	(2.86)	(2.48)	(2.67)
Age (age 20-55; 2007)	-0.0032	-0.0020	-0.0030	-0.0074
	(0.75)	(0.40)	(0.66)	(0.75)
Female (age 20-55; 2007)	-0.1071	-0.1215	-0.1152	-0.1118
	(0.67)	(0.72)	(0.69)	(0.41)
Number of hh members (age 20-55; 2007)	0.0054	0.0050	0.0016	0.0028
	(0.20)	(0.17)	(0.05)	(0.08)
Positive crop income in 2007	-0.0348	-0.0383	-0.0458	-0.1431
	(0.68)	(0.71)	(0.82)	(2.05)
Province fixed effects	yes	yes	yes	yes
R squared (within)	0.0107	0.0177	0.0150	0.0208
Number of observations	1196	1189	1189	643

Numbers in parentheses are absolute t values using robust standard errors with province clusters.

Table 5 Machine investments

Dependent: Machine investments			
Real wage growth: Non-agriculture	-5571899	-3054478	-5793576
	(0.99)	(0.47)	(0.97)
Real wage growth: Agriculture	-758798.9	255020.9	-534213.9
	(0.28)	(0.12)	(0.19)
Real wage growth: Non-agriculture * self-cultivated land 2007		-1946892	
		(1.32)	
Real wage growth: Agriculture * self-cultivated land 2007		-808278.3	
		(0.75)	
Real wage growth: Non-agriculture * log self-cultivated land 2007			-1648634
			(0.85)
Real wage growth: Agriculture * log self-cultivated land 2007			1631374
			(2.02)
Years of schooling (age 20-55; 2007)	100507	961211.3	990922.8
	(1.46)	(1.40)	(1.46)
Age (age 20-55; 2007)	243470	250196.3	233200.9
	(1.70)	(1.69)	(1.65)
Female (age 20-55; 2007)	-1.52E07	-1.52E07	-1.47E07
	(3.00)	(2.82)	(2.82)
Number of hh members (age 20-55; 2007)	2853668	2879816	2849581
	(1.40)	(1.41)	(1.39)
Self-cultivated land 2007	2278766	3352835	2151682
	(1.79)	(2.22)	(1.73)
Not-owned self-cultivated land 2007	2292918	2173216	2263271
	(2.19)	(2.07)	(2.13)
Province dummies	yes	yes	yes
Pseudo R squared	0.0170	0.0175	0.0174
Number of observations	1225	1225	1225

Numbers in parentheses are absolute t values using robust standard errors with province clusters.

Table 6 Crop income and productivity growth

Dependent: Change in log of	Crop income				Per-ha crop income	
Sample:				Land>0.6 ha		High wage growth
Change in self-cultivated farm land		0.3002	0.2809	0.1351	-0.2095	-0.3332
		(2.66)	(2.45)	(1.11)	(1.33)	(1.49)
Change in self-cultivated farm land owned	0.2747					
	(2.70)					
Change in self-cultivated farm land not own	0.3318					
	(1.81)					
Machine investment		3.46E-08	4.38E-08	9.33E-09		
		(1.63)	(1.76)	(0.38)		
Change in self-cultivated farm land * Machine inv			3.35E-08	4.90E-08		
			(1.52)	(2.58)		
Change in self-cultivate farm land squared					0.0143	0.0288
					(0.70)	(1.08)
Change in self-cultivated farm land * self-cultivated land 2007					0.0660	0.1073
					(1.81)	(2.24)
Village fixed effects	yes	yes	yes	yes	yes	yes
R squared (within)	0.0188	0.0201	0.0214	0.0126	0.0036	0.0770
Number of observations	968	967	967	476	765	454

Numbers in parentheses are absolute t values using robust standard errors.