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Does land tenure form affect farm level productivity? The answer, from farm level data for oil palm from the Hoskins project in West New Britain province of Papua New Guinea, is in the affirmative. Analysis of farm level output, controlling for all measured inputs, shows systematic differences in productivity across three land tenure types; namely, farms under customary purchase agreements (CP), those under the land settlement scheme (LSS), and those under village owned land schemes (VOP). The evidence is that productivity is higher under the CP and LSS schemes compared to the VOP arrangement. The empirics suggests that the higher productivity is due to benefits from economies of scale enjoyed by farms with improved tenure security and from the absence of sharing of income and harvesting effort that is present on farms with insecure tenure.

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Abstract

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I. Introduction

The relationship between land tenure security and agricultural productivity remains a hotly debated issue. While several theoretical papers suggest that secure property rights to land such as those provided for under individualised title is likely to raise investments, improve access to credit, and induce greater effort on the part of the owners, the empirics in support of these propositions has been both scarce and less than convincing.[1] This lack of evidential support to the hypothesised links between tenure-security and agricultural productivity could be due to several factors including the absence of such a link, the inability to measure outputs and inputs correctly, and the difficulties of trying to control for all possible factors that impinge on agricultural productivity. The motivations for deciphering the contribution of tenure forms on agricultural productivity, however, are compelling. Much of land reforms programs within poor agrarian economies such as those in Africa and the Pacific are premised on the assumption that improved tenure security will lead to increased agricultural productivity and thus reduce rural-poverty. Land reforms in Papua New Guinea, the context for this paper, were motivated by these very considerations.

This study uses farm level data from a tree crop, Oil Palm, grown in West New Britain Province in Papua New Guinea. Several features of this case study make it ideal to an analysis of the contribution of alternative forms of land tenure arrangements on agricultural productivity. Oil Palm, being a tree crop with a productive life of some 20 years, makes tenure security a pre-requisite for its cultivation. The crop is cultivated on

[1] See Besley, 1995 and Myyra et al, 2007 for the affirmative case and Gavian and Ehui, 1999 and Jansen and Roquas, 1998 for a counter case)

an estate by the company that mills the fruit and exports the oil and the by-products. However, some 7000 smallholders working on blocks of land surrounding the company estate grow Oil Palm and supply fresh fruit bunch (FFB) to the milling company at a price linked to the world market price for the exports. The smallholder sector, thus, comprises a competitive fringe to the 'nucleus' estate run by the milling company. The output of the crop is homogenous, thus productivity is easily measured in terms of output of FFB in tons per year per hectare of land. All of the inputs other than land and labour used by the smallholder sector in producing the FFB are provided for by the milling company, often on short-term credit, thus there is little heterogeneity in terms of the quality (as against the quantity) of inputs used by the smallholder sector. The major item of technology that impacts on yield is the sub-species of seeds used – this once gain is provided for by the company.

The quality and quantity of land used differs across the individual smallholders. But even here, the government had fixed the size of the blocks to six hectares when settling the smallholder growers on state land. The company, moreover, restricts planting by issuing a fixed number of seedlings to a grower.[2] While the quality of land is less than uniform, the extent of variation across farms in terms of terrain and fertility is minimal as the crop has very specific needs in terms of the soil type and water, factors that were taken into consideration when the land was first made available for settlement by the smallholders. These considerations remain paramount in the expansion of farms within the vicinity of the mill. The company provides transportation to the mills at a uniform cost to the growers, thus the incentives to produce the crop is the same regardless of the

[2] There is, however, some evidence of a black market in seedlings.

spatial distribution of the farms. The farmers, however, have complete freedom in the choice of the quantity of variable inputs such as labour, fertilizer and herbicides applied. Of most relevance to this paper, the smallholder sector operates from three distinct land tenure arrangements, namely: the original land settlement schemes (LSS hence forth) where State land with a lease of 99 years was availed for growing the crop; and, another two distinct arrangements that operate on land held under customary title. Within the latter group, settlers from outside the region have purchased land for growing Oil Palm from the customary owners (referred to as CP blocks henceforth) and farms operated by the customary owners themselves under village owned plantations schemes (VOP blocks henceforth).

We thus have a case of a tree crop grown on land held under three distinct tenure types using inputs that are close to being homogeneous. Our analysis on productivity, controlling for all measured inputs, shows that CP-land is on average the most productive, closely followed by LSS-land, with VOP-land being the least productive of the three. While the average productivity of CP-land is not statistically significantly larger (at the 5 percent level of significance) from LSS-land, the above-mentioned two have average productivities that are clearly greater than that of VOP-land. In terms of input usage, we find that farms on CP and LSS tenure are generally larger in area and make greater use of herbicides compared to farms run as VOPs. These finding, drawn from a carefully executed survey and subsequent statistical analysis, shows that tenure-type is a significant determinant of agricultural-productivity.

We search for the specific channels via which the specific tenure arrangement impinges on the level of farm productivity. Our analysis shows that the VOP schemes lack the exclusive rights to income from the crop; they use greater quantities of variable inputs per hectare under crop, and have on average lower yield per hectare than the other two tenure-forms. Some of these same issues were observed on LSS blocks where inheritance rights remained murky, the crop was grown by the extended family, and the proceeds from the sale of the FFB was shared amongst the extended family. Exclusive rights to the stream of income from the crop by the grower, thus, were another crucial determinant of farm-level productivity.

The rest of the paper is organised as follows. Section 2 provides a succinct summary of the extant literature on land tenure and productivity. Section 3 provides the settings for the subsequent analysis. Section 4 provides the conceptual framework, the data, and the empirics of this analysis. Section 5 concludes.

II. Land tenure and productivity: a brief survey

The contribution of property right regime to agricultural productivity and thus economic growth can be placed within the broader literature on institutions and their role in development. Land tenure arrangements and their contribution to agricultural productivity picks on a strand of this much broader literature. The policy implications of this research, however, are substantial. Most of the land reforms being undertaken in several developing countries is premised on a positive and quantitatively significant causal impact of tenure security on agricultural productivity (see World Bank, 2003 for an extensive survey of this literature). A number of governments in developing countries with financial and technical support from donor agencies have initiated and pursued land reforms as part of their poverty-reduction programs. Papua New Guinea, and the Pacific island as a group, has not been immune from this influence.[3]

Most of the international empirical literature on land tenure arrangements and farm level productivity is based on data collected from the Asian and African continents. One set of studies, mostly drawing on the Asian experience, lends support to the proposition that tenure security raises agricultural productivity. Feder, Onchan, Chamlamwong, and Hongladarom (1988), for example, use farm-level data from rural Thailand to argue that increased tenure-security raises agricultural productivity. Feder and Nisho (1999) provide a survey of a decade of published empirical research from developing countries, coming to the conclusion that the evidence from South East Asia and Latin American countries is one of a positive association between tenure security, access to credit, the levels of investment, and farm-level productivity. The evidence from studies on the African experience, however, is less than conclusive on the hypothesised link between tenure security and agricultural productivity. Smith (2004: 1463) notes that: "[t]he interaction among land tenure, fixed investments, and productivity may therefore be far from linear, and research to date leaves old questions only ambiguously answered".

Tenure security is hypothesised to impact on agricultural productivity via two distinct channels: first, via improving access to credit (Carter and Olinto, 2003); and, second by inducing long-term investments via reducing uncertainty with respect to the rights to the

[3] The recent literature has replaced land reform with administration.

future income (Schweigert, 2006). These two channels complement each other in that the first avails the credit to enable long-term investments for raising income. Oil Palm is an excellent case in point given that it is a tree crop that begins to bear fruit 18 months after planting and continues to do so for the next 20 years, but with annual yields very much dependent in application of variable inputs. Within the last, the input of labour for harvesting is essential for the realisation of any income in any given period. The palms are killed and the land replanted on a 20-year cycle. We consider the investment channel for the smallholder oil palm sector in Hoskins here simply because access to credit has been found not to be a crucial determinant of productivity (see Yala, 2007 on the last claim).

III. The Setting

The primary data for the analysis that follows is drawn from a purpose built and conducted survey within the smallholder oil palm sector within the Hoskins project, located in the West New Britain province of Papua New Guinea. Map 1 shows the location of the Hoskins Oil Palm Project while Map 2 provides details on the province itself. Papua New Guinea has a total of five oil palm projects, shown on Map 1, each built around a nucleus estate designed to provide the minimal necessary throughput to sustaining the milling operations of the company. The milling company provides support services to smallholders from the surrounding regions to grow the crop and sell their produce to the company. To date, this model has been successfully used throughout Papua New Guinea and is being trailed in neighbouring Solomon Islands.

Papua New Guinea (PNG), with a total population of some 6 million and a land area of some 6400 square kilometres, is the largest of Pacific Island Countries (PIC). The nation on independence in 1975 from Australia inherited a two-tiered land tenure system. Some 3 percent of the total land mass classified as State land is what was alienated by the colonial government as freehold. This land is governed by an English-based statute law. The remaining 97 percent is held under customary title and administered via customary law with the latter sanctioned by the *Underlying Law Act (2000)* and the *Papua New Guinea Constitution*. Most of the customary land remains to be surveyed and registered, thus land disputes are common, particularly when developments take place or are proposed. To complicate matters further, customary practices differ in detail considerably across the nation which has a total of some 800 distinct languages. Land under customary system is passed across generations through two distinct channels; via the females, this being the matrilineal system that is practiced within the Hoskins area; and, through males, this being the patrilineal system practiced in many other places within the province and elsewhere in the nation.

Smallholders growing oil palm on LSS-Blocks are either decedents of the first settlers that were brought in by the colonial government or those who have purchased land from the original settlers (see Hulme, 1984 for the genesis of this scheme). The LSS blocks have 99 year agricultural leases from the State, are each of 6.5 hectares in size, with leases issued in the name of the first settler. While purchases of the leases are still possible and the leases transferable, many of the existing growers are descendents of the original settlers with many of the occupants without a formal title to the land farmed.

The original lessees of Hoskins were selected by the colonial government through a competitive process in 1968 and were provided with assistance in the form of subsidised credit and inputs to start farming. Many of these families have expanded whilst remaining on their blocks since. In some cases, the extended family harvest in turns, hold multiple ATM cards, and thus draw on the proceeds from the sale of FFB on a rotation. The VOPs, in contrast, comprise smaller surveyed blocks on customary land deemed suitable for growing of oil palm by the industry. The customary owners, after acquiring their (VOP) blocks, then choose to either grow the crop or sell (lease) their landholding to others.[4] The latter comprises what we call the CP-blocks where the purchasers are from outside the landowning community. These purchasers sometimes acquire multiple, and often contiguous, blocks thus the farms range in size from 2 to 10 hectares. Some of the VOP-blocks are also amalgamated into larger blocks, but this has been less common compared to the CP-blocks.

The difference in land tenure arrangement used to grow oil palm using close to homogenous technology and inputs provides us with the data to test the contribution of each of the above-mentioned tenure arrangements on farm-level productivity. The results from this analysis have applicability beyond Hoskins and the Oil Palm industry, an important fact given the Government's 2006-launced land administration program aimed at raising agricultural productivity and accelerating development. The research results reported in this paper is of potential value to this program.

[4] The 'sale' is negotiated between the parties and often constitutes a lease with an upfront payment followed with regular implicit lease payments.

IV. The Analytical Framework

The two principal methods used for productivity analysis include the use of index number approach (see Gavian and Ehui, 1999 as an example) or the use of econometrics. Each has its own advantages and weaknesses, but both draw on a simple production function of the form:

$$Q_i = F(X_i, T_i, D_i) \qquad (1)$$

Where Q is the level of output, X constitutes a vector of inputs, T denotes technology, D is an indicator (dummy) variable that takes a value of unity when a particular feature is present for the particular observation and zero otherwise, and 'i' indexes for the individual observations. The function 'F', the farm in this case, transforms the inputs together with any traits intrinsic to the farm into output Q. In the case of multiple outputs and inputs and with prices that gyrate over time, the index number approach, as illustrated in Gavian *et al*, 1999, provides a better means to computing productivity compared to the use of the econometric technique. The use of econometrics is particularly hampered by the lack of a sufficient number of observations. In the case being explored here, we have a single output, a sufficiently large number of observations and thus the necessary degrees of freedom, and data for a single period and with homogenous prices both for the inputs and the outputs which all make the use of the econometric methodology more appropriate.

For analytical tractability, we assume the function 'F' to be Cobb-Douglas. All farms are also assumed to have access to a uniform technology. The production function in (1), thus, is assumed to take the form:

$$Q_i = T[\prod_j X_j^{\beta_j}]_i e^{D_i} \qquad (2);$$

where D denotes the dummy variable, in this case the tenure type, noting that the objective of this paper is to decipher the impact of land tenure type on productivity. Taking the natural log of equation (2) after using land, a constituent of the vector of inputs X, as the numeraire, gives:

$$\ln\left[\frac{Q}{N}\right]_i = \ln[T] + \sum_{j \neq N} \beta_j \ln[x_{ji}] + [\sum_j \beta_j - 1]\ln[N] + \delta[D]_i \qquad (3)$$

Where N denotes the land area, lower case *x* denotes the intensity of use (that is the quantity of input used per hectare of land) of the respective inputs in the vector X, 'j' indexes the individual inputs, and β is the input-elasticity. In the case of a linearly homogenous production function of the form shown in equation (2), the term $[\sum_j \beta_j - 1]$ will equal zero; this term being strictly positive would denote the presence of economies of scale, an issue that is tested explicitly in the empirics that follows. Equation (3) decomposes the potential sources of differences in land-productivity across farms into three sources; namely, those due to differences in input intensities such as the usage of fertilizer and herbicides per hectare of land, that due to economies of scale, and those arising out of attributes, such as land tenure type, captured within the dummy variable D above. The estimable form of equation (3) that is used in the empirics that follows take the form:

$$\ln\left[\frac{Q}{N}\right]_i = \alpha_0 + \sum_{j \neq N} \beta_j \ln[x_{ji}] + \gamma \ln[N_i] + \delta[D_i] + \varepsilon_i \qquad (4).$$

where ε_i capture farm-specific idiosyncratic factors and any measurement errors in the data. The parameter estimates from equation (4) can be mapped back to the production function given as equation (2).

While farmers have little choice in the quality and possibly the range of inputs they have access to, they have complete flexibility in choosing the quantity of each input that they use. In other words, input intensities (the x_j's) in equation (4) may be determined by the land-tenure type, that is D_i. This is explicitly tested for by estimating input intensities by land-tenure type of the form:

$$x_k = \alpha_0 + \sum_{j \neq k} \varphi_j x_j + \sum_i \theta_i D_i + \nu_i \qquad (5).$$

When the dependent variable in equation (5) is binary, that is, it takes either a value of one or zero such as whether herbicides are used or not; the model is estimated both as a linear probability model and a probit model.

V. Data and Empirics

The list of growers as of 2003 was obtained from industry body. Data from the estate company was then used to subdivide the smallholders into the three land tenure types; namely, LSS, VOP, and CP. A random sample, stratified by land tenure type, of growers was then taken (Deaton 1997:38). Each of these growers was then approached and the requisite data collected on farm size, production, use of inputs, other sources of income, and their access to credit. This data was then complemented with the information obtained from the milling company. The number of growers chosen per land tenure type was as follows: 48 from LSS, 48 from VOP, and 32 from CP arrangement. Thirty additional growers from each group were selected as reserves for replacement during the survey. The reserve list was used when the first selected growers were difficult to find, either because they were out of the province, in hospital, or could not be found after making three attempts. Taking into account cost in terms of both time and money, the sample used is an appropriate sample size (Bartlett, Kotrlik, and Higgins, 2001).

Table 1 provides summary statistics of the variables for which data had been collected via the survey. In terms of household characteristics, the average age of the household head was nearly 43 years, some 90 percent of the household heads were males, some 16 percent of the household heads had outside employment, and each household comprised an average of 6 adults and some 5 dependents. The distribution of these characteristics was far from uniform; the oldest household head in our sample was 80 years of age while the largest household had some 17 adults. One household held 7 blocks under oil palm while another had just 58 percent of a block under the crop. Access to income from the harvest of oil palm was organised around the number of bank cards held by the household. Payments from the purchasing company, New Britain Oil Palm Limited (NBPOL), are credited into the nominated bank accounts of the growers. The individual households access these funds, on internal arrangements, on the basis of ATM cards held by the members of the (extended) family. Families, on average, held two ATM cards with a case of some 5 cards held by an extended smallholder household. The arrangements within families ranged from savings via specific accounts for particular purposes such as for weddings, school fees, church contributions, etc. Some families organised their harvests in rotation, thus payments were accessed on the basis of the group engaged in the harvest of the crop.

In terms of land characteristics, the average area of a block is 6 hectares, output per farm is some 27 tons of fresh fruit bunch per year, only 14 percent of the sample held a title to the block, and some 58 percent of the block holders had expanded on the area under cultivation since settling on the block. On use of variable inputs, fertilizer use ranged from nil to 80 bags with an average use per block of 13 bags. Of note is the fact that a number of growers made nil use of variable inputs; reasons for which are explored in some detail in the modelling of productivity that follows.

Results

The modelling that follows uses the hectares of land used for growing oil palm per block as the numeraire. Productivity is measured in terms of tons of Fresh Fruit Bunch (FFB) produced per hectare of land under oil palm. The intensity of input usage is also quantified in terms of per hectare of land under the crop. The first part of the analysis examines correlates of productivity with tenure type. Of the 108 farms for which output data was available, 91 did not have a title. The average output of FFB per hectare of land under oil palm for titled farms at 6.65 tons was 0.12 tons greater than that for untitled farms. This difference, however, was not statistically significant at the 5 percent level. Amongst other noticeable correlates was a positive and statistically significant relationship between having other sources of income and a title. The causation between these variable could run in either direction: having other income may provide the liquidity to acquire a title or having the title in the first place may enable the holder to invest in a business as a source of off-farm income. There was anecdotal support for both of these propositions. Separating out the contribution of each of these channels is part of ongoing research. Informal rents were only paid on CP blocks. In terms of usage of variable inputs, fertilizer and herbicide use was found to be statistically significantly associated with larger farms; this could reflect economies of scale in the application of the above and/or the greater substitution possibilities between use of household labour on smaller blocks with the use of herbicides on larger blocks.

Table 2 shows the levels and distribution of productivity and input usage across the three land tenure arrangements and that for the survey-sample as a whole. The average output per hectare of crop under oil palm, this being the measure of land-productivity, is shown in the third raw for the 108 farms in our sample of 128. The average land-productivity was 6.55 tons with a minimum of 0.25, a maximum of 29.15, and a standard deviation of 4.19. Note the differences in land-productivity across the three land tenure types. The average for CP farms was 8.56 compared to the corresponding figures for LSS and VOP farms of 6.23 and 5.50 (tons per hectare), respectively. Average land-productivity, measured in terms of output of FFB per hectare of land, is statistically significantly greater at the 1 percent level under customary purchase agreement (CP) compared to the rest of the farms with a corresponding figure of 5.88.[5] While the average figures show that the LSS Blocks come next in terms of average productivity, this difference is not statistically significant at the 5 percent level. The data in Table 2 also shows differences

[5] The p-value of a mean greater for CP blocks compared to the rest is 0.9982.

in the intensity of input usage across the three land tenure types. The averages show that the VOP Blocks use more labour and fertilizer per hectare of Oil Palm; and, they are on average nearly one half and one third the size of CP and LSS Blocks, respectively. Total factor productivity of VOP Blocks, therefore, is the lowest amongst the three land tenure forms.

The determinants of farm productivity was next examined by estimating equation (4) above using data for the 88 farms for which the full set of requisite data was available. The regression estimates and the diagnostics are reported in table 3 below. Colum 1 in table 3 reports results of a regression of the log productivity on log fertilizer use, log labour employed, and the two land tenure types, CP and LSS, with VOP being the excluded category. While fertilizer use and land tenure type have statistically significant impact on land-productivity, the coefficient estimates for labour, though positive, is not statistically significantly different from zero. Of interest to this paper is the fact that CP land tenure type has an average total factor productivity 1.76 times that of farms under VOP arrangements while the corresponding figure for LSS farms is 1.95 when inputs of fertilizer and labour is held constant. This finding is different from the simple comparisons of land-productivity provided above.

Column 2 provides estimates from an expanded model that includes Size and Size-squared, to account for possible diminishing returns to scale, the Age and Age-squared terms, to capture possible contribution of experience and its diminishing returns, the same for the years of education of the household head, and a dummy variable for Title to capture the potential contribution of having a title on farm productivity. The coefficient estimates compared to those reported in column 1 are similar. We thus only consider the parameter estimates for the additional variables introduced in the model. The coefficient estimate for Size is positive and statistically significant. The parameter estimates on Size and Size-squared suggest that farm productivity is maximised at a Size of approximately 4.6 hectares; this being somewhat greater than the mandated 4 hectare plantations per block. None of the other variables, however, have a statistically significant association with farm-level productivity. The results in table 3, thus, show that CP and LSS tenure types are more productive than VOP arrangements, but why?

Table 4 explores input usage by tenure type through estimation of equation (5) above. Column 1 of table 3 reports OLS results while columns 2 and 3 report results from linear probability estimates; the latter results are similar to those from probit estimates. Amongst the statistically significant partial correlates for fertilizer use is Size while that for herbicide use is both Size and CP and LSS land tenure forms. Hired labour does not show a statistically significant association with any of the land tenure forms. Thus, land tenure form seems to be a significant determinant of the use of fertilizer and herbicide; this being the case even when scale effects are controlled for. CP and LSS farms make greater use of variable inputs compared to those under VOP arrangements. This fact, however, cannot explain the greater productivity observed in the estimates reported in table 3 since these estimates have already accounted for input usage in the estimates. Table 4, therefore, considers the potential scale and effort channels for the higher productivity observed in CP and LSS farms compared to VOP farms.

Table 5 investigates factors that are correlated with farms being expanded and those where harvesting is undertaken in rotation. On the first, farms under both LSS and CP land tenure arrangements have experienced expansion in the area under oil palm. In terms of the second, however, it is only LSS-farms that have had a tendency for harvesting in rotation. This may be partly due to the fact that LSS farms are older and thus house larger households, and sometimes families extending three generations. This practice of dividing the proceeds from the harvests would be a disincentive to investments and exertion of effort into increasing yield, thus may explain the lower productivity of LSS farms vis-à-vis those under CP arrangements. Establishing this direction of causation conclusively, however, is tricky. CP growers, for example, have smaller families but also comprise individuals who have taken the initiative to acquire land for growing of the crop. These individuals, thus, may have the intrinsic qualities of risk-taking and a belief in their capacities to improve on their wellbeing through farming on land acquired through CP-arrangements. Imputing for the above in the difference in total factor productivity between CP and LSS farms is part of ongoing research.

VI. Policy implications

The empirics in the last section suggest that land tenure form is correlated with the farm level productivity. This finding is based on survey level evidence on output of a single homogenous commodity produced with uniform technology and material inputs. Farmers, however, have had freedom to choose the quantities of inputs used and the level of effort expanded in producing the output. Farm sizes have differed considerably, thus the potential benefits of economies of scale have been accounted for in computing the levels of farm-level productivity. The results suggest that the benefits of economies of scale for the smallholder sector is maximised at approximately 5 hectares; most farms fall well short of this figure. The first policy lesson from this exercise, therefore, is that a relaxation of regulatory barriers to expansion of farms, thus, may deliver gains in productivity. It has been noted that only LSS and CP blocks have expanded, thus scale effects seem to favour these two land tenure types over VOP blocks – the smallest of the three. The second policy lesson from the above may be that it is the lack of secure tenure that is constraining expansion and thus productivity improvements on the VOPs.

The parameter estimates reported in table 3 suggest that CP and LSS farms have productivity greater than VOP blocks. If this difference is due to tenure type, then land reforms aimed at availing greater tenure security has the potential to raise farm level productivity. Harvest in rotation, however, seems to be present only within LSS blocks. This may explain the lower productivity of LSS blocks compared to CP blocks where households do not engage in such practices. This difference is not due to differences in tenure security *per se*, but more likely the outcome of large families resulting from the long-established settlers on LSS blocks. Many of those now on CP blocks are former settlers from LSS blocks, thus the CP blocks may have attracted the most entrepreneurial of the LSS farmers. The higher productivity of the CP blocks, thus, may at least be partly the result of this ‘selectivity’ bias. Purging the contribution of the above in computing farm level productivity is a difficult exercise, but the policy implications of the above are unambiguous. Allowing for greater access to CP arrangements for oil palm and permitting the setting up of larger blocks has the potential to enhance farm level productivity by drawing in the most entrepreneurial investors, through the benefits of economies of scale, and through reduced income and effort-sharing practices.

VII. Conclusions

We started off by asking whether land tenure type impinges on farm level productivity. The answer, according to the research results reported in this paper, is in the affirmative. This has been shown via the application of a simple analytical framework on survey level evidence from 128 smallholder oil palm blocks from Papua New Guinea. This data lends itself to the proposed analysis neatly since a homogenous output is produced and sold to a single buyer at a predetermined price using close to identical inputs except for the land tenure arrangements on the land used to grow the crop. The findings lend considerable support to the proposition that the form of land tenure matters for farm level productivity.

This result holds for this specific case, but could hold more generally, particularly when tenure security on productivity works via the following identified channels. We find that farms expand only when tenure security is present, thus the realisation of productivity gains from economies of scale requires tenure security. To the best of our knowledge, this particular channel of the link between land tenure form and farm-level productivity has not been noted in the extant literature. Second, sharing of proceeds from the sale of farm output lowers the incentives for expanding effort and resources into long term investments. The impact of the above is particularly punitive in the case of a tree crop where investments have long gestations. Once again, greater security to the proceeds of investment to an individual grower/household has the potential to induce increased investments and effort, both of which would raise income and farm level productivity.[6]

Finally, agricultural productivity can be raised through land reform if and only if land tenure type has a causal impact on farm-level productivity. This is found to be true for oil palm sector within the West New Britain province of Papua New Guinea. The channels of influence from land tenure form to farm-level productivity is via scale effects, and disincentive effects of income and effort sharing common on farms with insecure rights to income from the sale of produce. Furthermore, customary purchase arrangements that attract the most entrepreneurial farmers, could also have contributed to the higher productivity of this tenure form. Each of the above observations has distinct policy lessons: the first suggests that improved access to land has the potential to raise the size of farms and with it the benefits of economies of scale; the second suggests that tenure security has the potential to increase long-term investments and effort at the level of individual farms and that greater security to proceeds from investment has the potential to improve farm-husbandry and consequently agricultural productivity; and, the third suggests that facilitating a land market on a competitive basis could raise agricultural productivity as a whole.

[6] Note that our data only captures the number of workers, not the hours spent on the farm.

References

Bartlett, E, J, Kotrlik, W, J, and Higgins, C, C., 2001, "Organisational Research: Determining Appropriate Sample Size in survey Research", *Information Technology, Learning, and Performance Journal (19(1):43-50.*

Besley, T.1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana", *Journal of Political Economy* 103(5):903-37.

Carter, M. R. and Olinto, P., 2003. 'Getting Institutions "Right" for Whom? Credit Constraints and the Impact of Property Rights on the Quality and Composition of Investment,' *American Journal of Agricultural Economics* 85(1): 173-186.

Deaton, A., 1997. *The Analysis of Household Surveys: A Microeconomic Approach to Development*, The Johns Hopkins University Press, Baltimore, MD.

Feder, G. and Nisho, A., 1999. 'The Benefits of Land Registration and Titling: Economic and Social Perspectives', *Land Use Policy* 15(1):25-43.

Feder, G., Onchan, T., Chamlamwong, Y. and Hongladarom, C., 1988a. *Land Policies and Farm Productivity in Thailand*, Johns Hopkins University Press, Baltimore, MD.

Gavian, S and S Ehui 1999. "Measuring the production efficiency of alternative land tenure contracts in a mixed crop-livestock system in Ethiopia", *Agricultural Economics* 20: 37-49.

Hulme, D., 1984. *Land Settlement Schemes and Rural Development in Papua New Guinea*, Unpublished PhD Thesis, Department of Geography, James Cook University, Townsville, Queensland.

Jansen, K and E Roquas 1998. "Modernising insecurity: The land titling projects in Honduras", *Development and Change* 29: 81-206.

Myyra, S, K Pietola, and M Yli-Halla 2007. “Exploring long-term improvements under land tenure insecurity”, *Agricultural Systems* 92: 63-75.

Koczberski, G, G. Curry, and K. Gibson 2001. “*Improving Productivity of the Smallholder Oil Palm Sector in Papua New Guinea: A Socio-Economic Study of the Hoskins and Popondetta Schemes*”, The Australian National University.

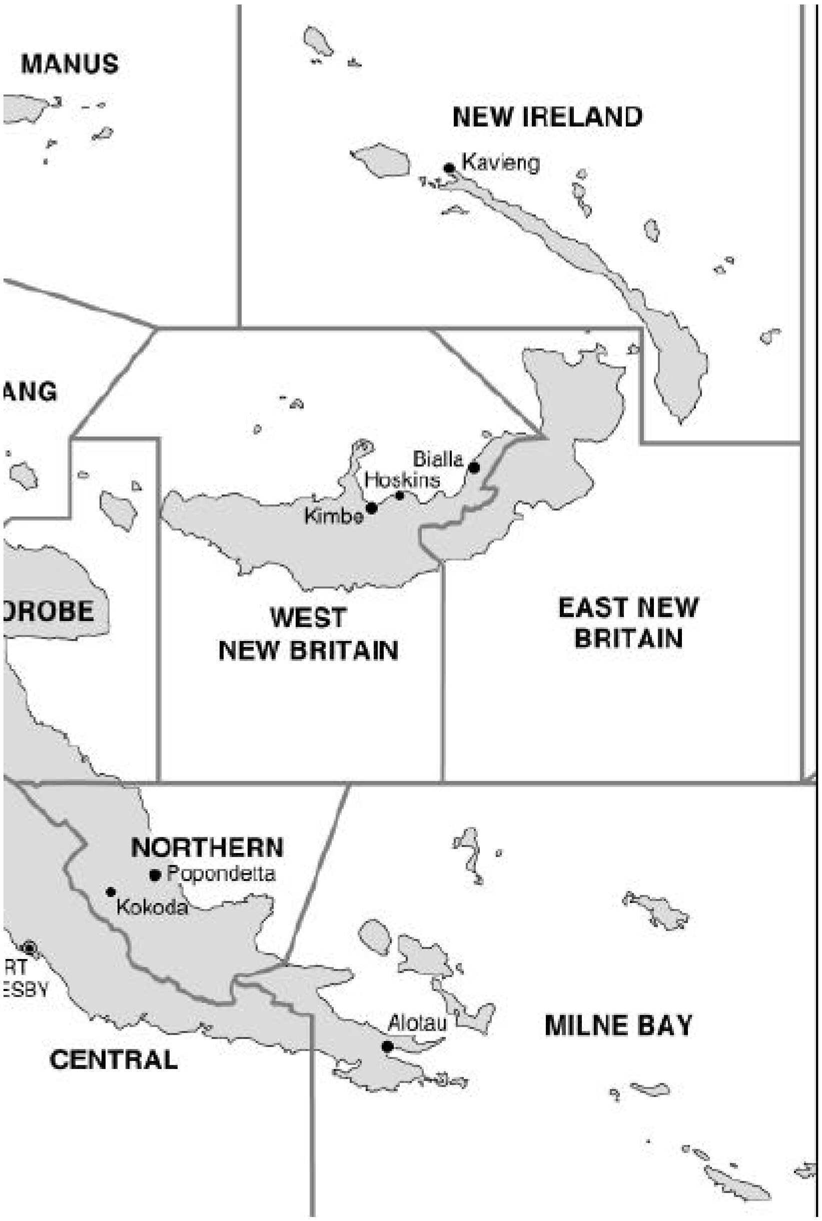
Smith, R E. 2004. “Land tenure, fixed investment, and farm productivity: Evidence from Zambia’s Southern Province”, *World Development* 32(10): 1641-61.

Schweigert. E, T., ‘Land Title, Tenure Security, Investment and Farm Output: Evidence from Guatemala,’ *Journal of Developing Areas* 40(1):115-26.

World Bank, 2003., *Land Policies for Growth and Poverty Reduction*. Washington DC.

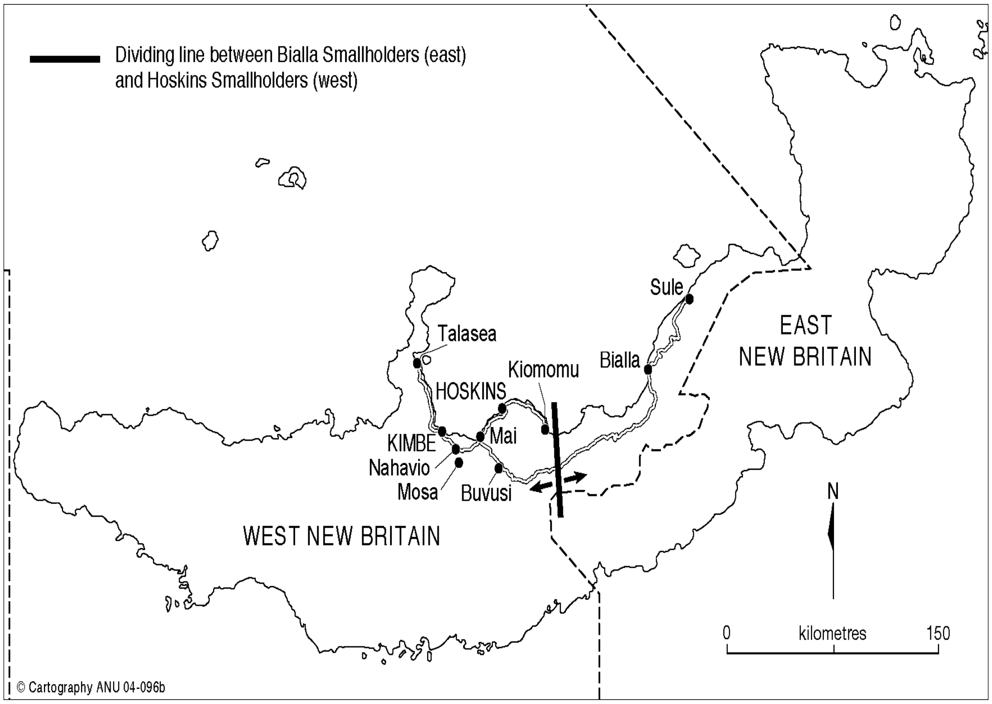
Yala, C. 2007. “Land Title and Access to Credit: Farm Level Evidence from Hoskins Smallholder Oil Palm”, Paper Presented at the Economics Research Workshop on Pacific Agriculture held at Lae in Papua New Guinea, from 16-17 July.

Map 1: Regions where Oil Palm is grown in Papua New Guinea



Source: Koczberski, et al, 2001.

Map 2 **Map of West New Britain Province**



Source: Yala (2007)

Table 1: Summary data for sample of households surveyed

Variable	Observations	Mean	Std. Dev.	Min	Max
Characteristics of household head and the household					
Age	128	42.59	13.38	22	80
Male	128	0.90	0.30	0	1
Outside employment	128	0.16	0.36	0	1
Education	128	6.63	4.05	0	17.4
Number of adults	128	5.50	3.10	1	17
Number of dependents	128	4.90	4.12	0	30
Number of cards	128	1.88	0.56	1	5
Own a business	128	0.36	0.48	0	1
Other income	126	205.81	274.25	0	2000
Number of blocks	128	1.09	0.58	1	7
Characteristics of land on which the crop is grown					
Hold land title	128	0.14	0.35	0	1
Area in hectares	128	4.20	2.18	2	10
Output in tons per year	108	26.61	18.77	0.49	77.46
Expanded the block	128	0.57	0.50	0	1
Input usage					
Fertilizer (bags per household)	128	13.21	12.01	0	80
Herbicide	128	0.51	0.50	0	1
Hired labour	127	0.39	0.49	0	1
Wheel barrow	128	0.59	0.49	0	1
Tractor	128	0.01	0.09	0	1
Hand tools	128	0.61	0.49	0	1
Knapsack sprayer	127	0.55	0.50	0	1
Advice from NBPOL	128	0.73	0.45	0	1
Training attended	128	0.42	0.50	0	1
Harvest in rotation	124	0.49	0.50	0	1
Share proceeds of harvest	124	0.85	0.35	0	1
Rotation	124	0.10	0.31	0	1
Other sources of income					
Cash crop	128	0.61	0.49	0	1
Run small business	128	0.04	0.19	0	1
LSS	128	0.38	0.49	0	1
CP	128	0.25	0.43	0	1
VOP	128	0.38	0.49	0	1

Table 2: Productivity and intensity of input use.

Variable	Observations	Mean	Std. Dev.	Min	Max
			All blocks		
Output	108	6.55	4.19	0.25	29.15
Labour use	128	1.60	1.12	0.10	5.50
Fertilizer use	128	3.47	2.74	0.00	15.00
Farm size	128	4.20	2.18	2.00	10.00
			CP Blocks		
Output	27	8.56	5.87	0.52	29.15
Labour use	32	1.92	1.41	0.25	5.50
Fertilizer use	32	3.92	2.29	0.00	10.00
Farm size	32	4.08	2.37	2.00	10.00
			LSS Blocks		
Output	42	6.23	2.81	1.66	12.90
Labour use	48	1.00	0.48	0.10	2.00
Fertilizer use	48	2.59	1.88	0.00	6.67
Farm size	48	6.11	1.02	4.00	10.00
			VOP Blocks		
Output	39	5.50	3.62	0.25	13.60
Labour use	48	2.00	1.12	0.50	4.50
Fertilizer use	48	4.05	3.47	0.00	15.00
Farm size	48	2.38	0.98	2.00	6.00

Note: Output and Inputs are all expressed in terms of per hectare of land, thus output is a measure of productivity. Units of measurement are as follows: Output is tons of FFB per hectare of Oil Palm; Labour use is number of adults per hectare of land; fertilizer use is number of 50 kg bags per hectare; and Farm size is in hectares.

Table 3: Regression results for productivity

	(1)	(2)
	lny	lny
lnf	0.485	0.534
	(0.182)**	(0.188)**
lnl	0.201	0.168
	(0.133)	(0.128)
cp	0.568	0.528
	(0.232)*	(0.223)*
lss	0.671	0.409
	(0.205)**	(0.249)
size		0.591
		(0.167)**
sizesq		-0.064
		(-0.014)**
age		0.030
		(0.036)
agesq		-0.000
		(-0.000)
educ		-0.027
		(-0.041)
educsq		0.002
		(0.003)
title		0.044
		(0.180)
Constant	0.564	-1.052
	(0.324)+	(-0.911)
Observations	88	88
R-squared	0.20	0.33
Ramsey's test (p-value)	1.02 (0.3885)	0.51 (0.6793)

Note: Robust standard errors in parentheses; + significant at 10%; * significant at 5%; and ** significant at 1%; Ramsey's test for omitted variables with the null hypothesis of no omitted variables. Test for normality was rejected for the model reported in column 1 of table 3 (p-value of 0.0429). This same test, however, failed to reject the assumption of normality (p-value of 0.8337) for the expanded model.

Table 4: Use of inputs by land-tenure type – OLS estimates

	(1)	(2)	(3) – LP Estimate
	fertilizer	herbicide	Hired labour
title	0.171	-0.006	0.189
	(2.909)	(0.125)	(0.153)
Other income	0.005	0.000	0.000
	(0.004)	(0.000)	(0.000)
Ln(y)	1.579	0.030	-0.003
	(1.067)	(0.041)	(0.071)
size	3.000	0.085	0.016
	(0.984)**	(0.029)**	(0.034)
cp	0.946	0.442	-0.184
	(1.799)	(0.131)**	(0.138)
lss	-4.675	0.279	-0.233
	(4.194)	(0.152)+	(0.179)
Constant	-1.810	-0.102	0.397
	(2.641)	(0.101)	(0.163)*
Observations	106	106	106
R-squared	0.26	0.38	0.04

Note: Robust standard errors in parentheses; + significant at 10%; * significant at 5%; and ** significant at 1%.

Table 5: Partial correlates of expansion and harvest in rotation – linear probability estimates

	(1)	(2)
	expanded	rotation
title	0.034	-0.251
	(0.052)	(0.152)
Ln(Other income)	0.040	0.065
	(0.035)	(0.055)
lny	0.021	0.003
	(0.068)	(0.069)
size	0.095	-0.053
	(0.030)**	(0.036)
cp	0.276	0.040
	(0.135)*	(0.152)
lss	0.467	0.325
	(0.133)**	(0.187)+
Constant	-0.291	0.298
	(0.180)	(0.281)
Observations	98	97
R-squared	0.64	0.06

Note: Robust standard errors in parentheses; + significant at 10%; * significant at 5%; and ** significant at 1%.