PN-ABF-251

LAND TITLES, TENURE SECURITY, AND AGRICULTURAL PRODUCTIVITY: THEORETICAL ISSUES AND AN ECONOMETRIC ANALYSIS OF MEDIATING FACTORS IN NJORO DIVISION, KENYA

Michael R. Carter, Keith D. Wiebe, and Benoit Blarel *

August 1989

(Revised March 1990)

* The authors are, respectively, Associate Professor and Graduate Research Assistant, Department of Agricultural Economics and the Land Tenure Center, University of Wisconsin-Madison, and Economist with the World Bank.

CONTENTS

EXECUTIVE SUMMARY vii

INTRODUCTION 1

SECTION 1 AGRICULTURE IN NJORO, KENYA: FARM SIZE DISTRIBUTION, FACTOR MARKET STRUCTURE, AND MODE OF ACCESS TO LAND 3

SECTION 2 IDENTIFYING THE ECONOMIC IMPACTS OF TENURE SECURITY PROGRAMS: THEORETICAL CONSIDERATIONS AND EMPIRICAL COMPLICATIONS 10

2.1 A Model of Title, Tenure Security, and Agricultural Productivity 10
2.2 A "Naive" Statistical Analysis of the Impact of Title in Kenya 13
2.3 Identification Problem 1: Title Effects versus the Mediating Impact of Market Access and other Farm Characteristics 17
2.4 Identification Problem 2: Security-Induced Demand Effects versus Credit Supply Effects of Land Title . . . 25

SECTION 3 FACTORS WHICH MEDIATE THE ECONOMIC IMPACTS OF TENURE SECURITY PROGRAMS: MULTIPLE MARKET FAILURES IN LAND, LABOR, AND CAPITAL 27

SECTION 4 IDENTIFICATION OF THE DIFFERENTIATED IMPACT OF LAND TITLE WITHIN IMPERFECT MARKET ENVIRONMENTS 33

4.1 Identifying True versus Spurious Effects of Land Title on the Economic Productivity of Njoro Agriculture . . . 34
4.2 Identification of Security-Induced Demand Effects versus Credit Supply Effects of Land Title in Kenya 36

SECTION 5 CONCLUSION AND POLICY RECOMMENDATIONS 43

APPENDIX A: THE NJORO DATA SET 44

APPENDIX B: REGRESSION RESULTS 46

NOTES 49

BIBLIOGRAPHY 50

TABLES AND FIGURES

Table 1 Size, Tenure, and Mode of Access Characteristics 7

Table 2 Value of Inputs and Outputs on Maize-Beans, Wheat, and Livestock Activities by Farm Tenure Status 14

Table 3 Deviations from Farm-Mean Quantities of Inputs and Outputs in Maize-Beans Cultivation by Field Tenure Status 40

Table 4 Ordinary Least Squares Regression of Field-Specific Deviations from Farm-Mean Levels of Inputs and Outputs 42

Figure 1 Njoro Farm Size Distribution 5

Figure 2 Investment & Eviction Probability 12

Figure 3 Investment of Market Access 18

Figure 4 Endogeneity of Title Status 21

Figure 5 Farm Income & Market Access 22

Figure 6 Output and Net Returns Per Acre 28

Figure 7 Area by Crop Activity 30

Figure 8 Factor Productivity by Farm Size 32

Figure 9 Output and Net Returns Per Acre 37

PREFACE

This study is part of the Land Tenure Center's comparative program of research on security of tenure and land registration initiatives in Africa. This four year research program has been carried out under LTC's Cooperative Agreement (ACCESS I) with AID's Bureau of Science and Technology and has involved a year or more of fieldwork in Somalia, Senegal, Uganda and Kenya, short-term work in other countries, and an extensive literature review. It has sought to understand, through study of a number of titling initiatives, the actual impacts of such programs. It is in the light of this experience that future proposals for titling programs must be evaluated, rather than solely in terms of a potential indicated by theory. Experience in the end suggests modifications to our theoretical models, more rigorous statement of their assumptions and an understanding of how far these assumptions apply in the cases which concern us.

The planning and fieldwork for the study was funded under the Program Support Grant by AID's Bureau of Science and Technology to the University of Wisconsin's College of Agricultural and Life Sciences, and was implemented under its Memorandum of Understanding with Virginia State University. The research on tenure was part of a comprehensive study of the economics of smallholder agriculture in the region. The Land Tenure Center utilized Africa Bureau Strategic Studies funds under its Security of Tenure and Land Registration Project to meet the costs of data analysis and write-up for this portion of the research. The Land Tenure Center appreciates the interest and support of many in AID/Washington, including David Atwood and Gloria Steele in the Bureau of Science and Technology; Pat Fleuret, Gerald Cashin, and Curt Reintsma in Africa Bureau; and Joan Atherton in PPC.

Our thanks to the authors, and to those to whom they express their appreciation in the Authors' Acknowledgements.

John W. Bruce, Project Coordinator
Security of Tenure/Land Registration

AUTHORS' ACKNOWLEDGEMENTS

This paper has been written under the auspices of the of the Land Tenure Center's Security of Tenure and Land Registration research program. In addition to the Land Tenure Center, financial support for this research has come from U.S.A.I.D., Egerton University College, and the Office of International Agricultural Programs, University of Wisconsin-Madison. We thank Mr. E. K. Ireri, Mr. G. Gichuhi, and Mr. B. Kitur of Egerton's faculty for their help in the supervision of data collection; Mr. Kangethe, Mr. Asira and Mr. Nduati, students at Egerton, for assistance in supervision and data collection; and Mrs. N. Kilongosi and Mr. D. Olieba for their patience in computer data entry. The authors are solely responsible for all analysis and opinions -- these should not be attributed to supporting agencies.

EXECUTIVE SUMMARY

The perception that existing land tenure patterns inhibit agricultural productivity in parts of Sub-Saharan Africa has incited interest in programs to provide individuals with registered titles to their land. Some studies suggest that tenure reform, by enhancing individual ownership security, may increase investment and improve the performance of the agricultural sector. Tenure reform does not, of course, operate in a vacuum -- there are other factors which constrain agricultural performance and which may obliterate effects of enhanced tenure security. This observation suggests two more subtle points:

1. Enhanced tenure security may have differential effects on producers who differ in the degree to which they are bound by these other constraints. The impact of tenure security for whom becomes a relevant question.

2. Measurement and identification of the impact of tenure reform also becomes more difficult statistically in as much as the better placed producers, most likely to be able to reap the benefit from tenure security, are also those most likely to seek out and obtain secure tenure. Those less favored are also least likely to have sought out and obtained secure tenure. Any simple comparison of the performance of the two groups is therefore likely to overstate both the impact tenure security per se has on those who seek it out and the impact it would have on those who choose not to seek it out.

The standard argument for tenure reform centers on uncertainty's role in discouraging investment on land which is held without long term security. As suggested by the standard argument, land title which enhances ownership security may induce investment and productivity increases from the demand side, as farmers become more certain of reaping investment's benefits in the future. These are the Demand Side, Tenure Security Effects. Registered title may also induce investment from the supply side, by affording the producer better access to credit. These are the Supply Effects of Title. However, in a world where access to markets is imperfect, one would theoretically expect that both of these effects may be limited to those farms which are already well-placed with regard to agricultural resources and markets. Land policies could thus have quite different effects on different classes of producers.

Kenya has had considerable experience with land registration and titling programs both before and after independence. An empirical investigation of the small scale farm sector in Njoro Division reveals that the apparent superiority (in terms of productivity) of titled farms is in fact due to the spurious correlation between title and market access. Labor, capital and insurance markets appear highly imperfect in Njoro and the differential access to them is shown to result in systematic size and market access-related differences in cropping patterns and technology choice. Any potential effects of land title on agricultural productivity are overwhelmed by farm size and market access when these latter factors are incorporated

into the analysis. In addition, a second analytical approach designed to identify the demand side effects of tenure security finds no evidence that such forces are active.

Efforts to enhance smallholder productivity via land tenure reform are thus likely to prove ineffective if conducted in a vacuum: title status appears to be less important in the determination of farm productivity than do other factors such as market access. Furthermore, in light of the relationship between these other factors and farm size, tenure reform's distributional effects may prove as worthy of continued consideration as are potential efficiency consequences.

Tenure Security for Whom? An Econometric Analysis of the Differential Impacts of Land Policy in Kenya

Michael R. Carter, Keith D. Wiebe, and Benoit Blarel

The perception that existing land tenure patterns inhibit agricultural productivity and growth in areas of Sub-Saharan Africa has incited interest in programs to provide individuals with registered titles to their agricultural land. Tenure reform, by enhancing individual ownership security, is expected to increase agricultural investment and improve the performance of the agricultural sector. A pioneering study of Thailand by Feder et al. (1988) suggests that these expectations, while clearly ambitious, are entirely reasonable.

Land registration and titling programs are not novel in Sub-Saharan Africa. Tenure reform carried out under the Swynnerton plan in Kenya in the 1950's gives that country claim to substantial experience with such programs. Perhaps more importantly, Kenya exhibits significant land scarcity; thus the economic value of land, and consequently the potential returns to land titling programs, should be relatively high.

Using a cross-sectional farm level data set from Kenya's highly commercialized Njoro area, this paper analyzes the impact of tenure status on agricultural productivity. The goals of this analysis are twofold. First, this paper tries to lay out in a clear and general way the problems which hamper easy identification and measurement of the impact of tenure reforms. It should be stressed at the outset that these problems are <u>not</u> substantively uninteresting methodological artifacts. They are rooted in the economic behavior and market structure which ultimately shape the impact of land tenure reform. A clear statement and understanding of these problems should

be of of general interest and value for land titling program design and research. In addition, integrating the analysis of land titling with consideration of market structure and other factors which influence title's effects helps shed light on the controversy over whether such programs prompt land concentration over the longer term. Applying lessons derived from this first exercise, the paper's second goal is to evaluate the productivity effects of those tenure patterns which have resulted from Kenya's particular experiences with land titling efforts.

This paper is organized as follows. Section 1 uses descriptive statistics from the Njoro dataset to describe the range of factors which temper the impact of tenure status on productivity and may hamper the identification of tenure reform program effects. Section 2 performs a series of preliminary or "naive" analyses of the Njoro data. Criticism of these analyses structures presentation of general theoretical concerns about the way tenure security influences agricultural performance. Section 3 substantiates the empirical relevance of these theoretical concerns by demonstrating the importance of non-tenure factors on agricultural performance. Section 4 then presents a unified analysis of the land title issue. Finally, in Section 5, we conclude that land tenure reform will likely prove ineffective if conducted in a vacuum: title status appears to be less important in the determination of farm productivity than do factors such as farm size and mode of access to land, together with their implications for access to markets, non-farm income, and wealth.

SECTION 1 AGRICULTURE IN NJORO, KENYA: FARM SIZE DISTRIBUTION, FACTOR MARKET STRUCTURE, AND MODE OF ACCESS TO LAND

The Njoro study area is located in what is described in the Farm Management Handbook (1985) as the Lower Highland Zone. Despite its location on the equator, the area's altitude gives it a sub-tropical climate. Rainfall in the area ranges from 850 mm to 1100 mm annually, and occurs in two seasons. Crops of high productivity potential are grown mainly during the first rains, and include wheat, barley, low maturing maize, peas, linseed, rapeseed, sunflower, cabbage, and kales. During the second rains, medium maturing varieties of barley and wheat are grown. Beans are grown on the lower topographical areas, along with beetroots and avocados. A variety of of other garden and food crops are also grown. Pasture and forage crops are grown because of the area's potential for dairy production.

During the colonial period, Njoro was a so-called "Scheduled Area," and agriculture was restricted to white settlers. Land was divided between large scale farms, ranches, and, in the upper zone, forest. Following independence it was felt, both for economic and political reasons, that the large scale structure of farming in the Scheduled Areas should be left intact. The large scale sector was perceived as an important source of foreign exchange earnings and a net exporter of food stuffs to urban areas. Intact transfer of the large farms to Africans took place through purchases either by private individuals or by land purchase companies or cooperatives.

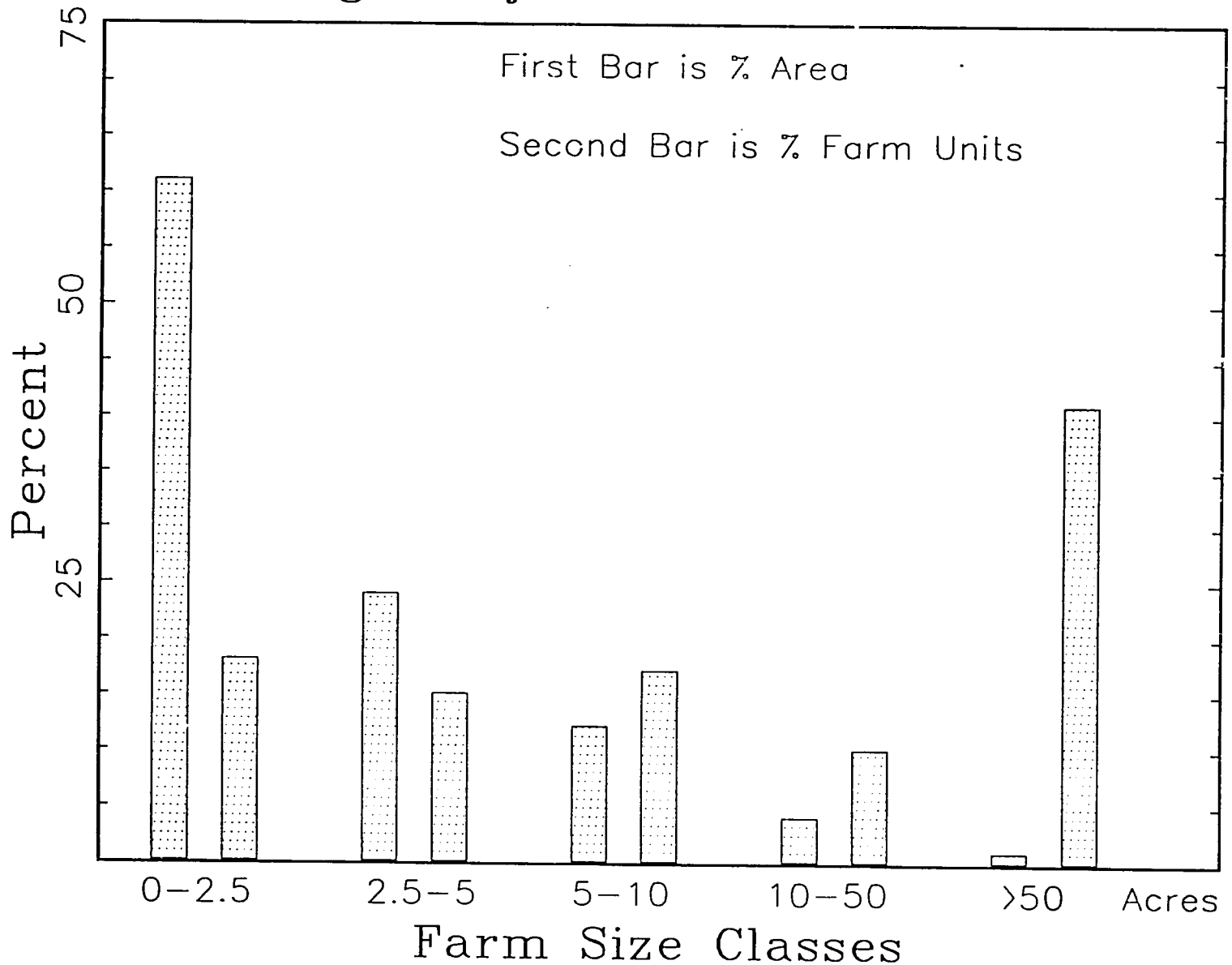
Some immediate redistribution and resettlement of small scale individual farmers did take place within the large scale agricultural and forest reserves of the Scheduled Areas. Yeoman schemes, the Million Acres Scheme and Squatter Settlement Schemes were among the programs which met these redistribution and resettlement objectives, the latter two being managed by

the Settlement Fund Trustees (SFT). On a national level, the three schemes transferred 17% of all land originally held by European settlers (Okoth-Ogendo 1981).

Njoro today contains almost the full range of the processes through which land has been transferred since independence. Large farms were bought intact by the SFT and redistributed to the landless. A Squatter Settlement Scheme opened up what was previously a forest reserve and also distributed portions of European farms to squatters. Through these various schemes, a new small scale farming sector emerged as individuals were allocated parcels of sizes ranging from 4.5 to 10 acres. In addition, those large scale units which were purchased intact by land buying companies and farmed initially as a single unit were also quickly (and unofficially) sub-divided among the share members. This de facto subdivision was ultimately ratified by the government (Fourth Development Plan 1979-1983). By 1986 more than a third of Njoro's ex-large farms had been subdivided by one mechanism or another; individual farm sizes today vary both within and between subdivided ex-large farms from 0.5 to over 20 acres.

With resettlement and subdivision in Njoro, average land holdings have decreased steadily in size. Agricultural land is now relatively scarce with 5.06 acres per household and 1.04 acres per person on average (Agricultural Census, 1979). The area's population density is 193 persons per square kilometre. Yet, as Figure 1 reveals, land ownership in Njoro remains concentrated. The strata of largest farms (those greater than 50 acres in size) comprises less than 1% of ownership units but controls approximately 40% of the agricultural area. In addition, the agricultural land controlled by the large farm sector is generally of better quality: characterized by

Fig. 1 Njoro Farm Size Dist



flatter terrain, and better served with feeder roads, water, and sometimes electricity. Subdivided ex-large farms -- and to an even greater extent settlement schemes -- are hillier, characterized by poorer soils, and are often poorly connected with major roads and water supplies.

The sample of farms analyzed in this study was drawn exclusively from the Njoro small farm sector created through post-independence settlement and subdivision processes. (See Appendix A for details regarding the sampling methodology employed.) Table 1 displays the size, tenure, and "mode of access" characteristics of the sample. Subsequent sections of this paper will argue that all three factors may influence agricultural performance and may interact in systematic ways.

As Table 1 shows, the 109 farms in the sample average 9.5 acres, and range from 0.98 to 82.68 acres in size. While this size range is relatively modest (because the sample excludes the large farm sector where units still measure in the thousands of acres), the labor and capital access of a 1 versus an 80 acre farm unit are likely to be quite different, with farms facing distinct effective prices and exhibiting distinctive economic behavior and productivity patterns. Section 4 below examines this likelihood in detail.

Table 1 also shows the distribution of farms by mode of access, meaning whether the farm was established through an SFT settlement scheme or via the subdivision of a large scale farm purchased by a land buying company. The final mode of access category includes those farms which are composed of rented or borrowed land. Of the 109 farms surveyed, only five had been purchased on an individual basis since their establishment as part of the original subdivision process; these are incorporated in the table on the

Table 1. Size, Tenure, and Mode of Access Characteristics

(Farm size class: a = acres)

Tenure/Access	a<=3	3<a<=5	5<a<=10	10<a<=20	20<a	All
All						
# farms	18	32	31	18	10	109
average size	2.1	4.2	7.8	15.1	35.3	9.5
maize (kg/a)	1046.2	782.5	946.4	1102.4	1756.0	1053.0
Title						
# farms	2	10	26	16	10	64
average size	2.7	4.4	7.9	15.6	35.3	13.4
maize (kg/a)	954.3	771.8	916.8	1181.7	1756.0	1125.4
No Title						
# farms	11	20	4	1	0	36
average size	1.9	4.1	7.5	11.1	--	4.0
maize (kg/a)	1160.0	837.7	1033.1	663.8	--	912.9
Rented/Borrowed						
# farms	5	2	1	1	0	9
average size	2.1	4.3	5.9	10.2	--	4.0
maize (kg/a)	879.3	399.7	1281.1	677.6	--	776.2
SFT						
# farms	3	25	25	4	0	57
average size	2.7	4.2	7.9	10.4	--	6.2
maize (kg/a)	991.7	750.4	905.3	1029.7	--	873.0
LBC						
# farms	10	5	5	13	10	43
average size	1.9	4.2	7.3	16.9	35.3	15.1
maize (kg/a)	1175.2	1172.3	1079.4	1170.8	1756.0	1332.0

basis of their original status. No transfers by inheritance were recorded.

Mode of access is a potentially significant factor because the wealth and other characteristics of land buying company shareholders are likely to be quite different from those of the participants in settlement schemes. The work of Collier and Lal (1986) has forcefully argued that access to non-agricultural income and wealth carries special significance in Kenyan agriculture, where factor (and particularly capital markets) are highly imperfect. As with farm size, mode of access is likely to signal the presence of other factors which may shape farm productivity, and which may be related to and condition the impact of tenure security.

Table 1 also divides farms into those which are held with title, those which are held without title, and those which are composed primarily of land which has been rented in or simply borrowed. A farm is considered titled if title has been issued for the parcel of land established in the original subdivision process. (Appendix A describes this parcel in detail.) Additional fields acquired subsequently may also be titled or untitled.

Sampled farms exhibit a range of tenure arrangements. Because of the different institutional environments under which land allocation took place, not all farmers have yet been granted an individual title to their land. On some SFT settlement schemes, individual land titles have been withheld awaiting repayment of the land purchase loan. Nor have all subdivided ex-large farms proceeded with the distribution of land titles to individual members. Problems of demarcation, plot size, allowance for public roads, and more importantly, sales of additional shares by unscrupulous managers, have hampered the titling process. It is the behavior of producers in these different tenure categories which this study will examine in its effort to

identify the economic impact of the security offered by individual land title, and to impute thereby the value of titling and registration programs.

It is important to note at this stage that such programs are highly controversial. Coldham (1979) and Haugerud (1983) note the persistence of customary tenure patterns despite efforts at formal registration. Okoth-Ogendo (1982) argues that title provision is neither necessary nor sufficient to enhance credit supply; Odingo (1982) makes the same point with respect to credit demand. Another often cited criticism of individual land registration and titling is its potential for increasing land distribution inequality [Njeru 1978, Okoth-Ogendo 1982, World Bank 1983, Shipton 1987]. Although there is little evidence with which to evaluate this criticism, land concentration was an integral part of the land tenure reform objectives set forth by the Swynnerton tenure reform plan in Kenya in the 1950's:

> "In future, if these recommendations are accepted, former Government policy will be reversed to enable energetic or rich Africans to acquire more land and bad or poor farmers less, creating a landed and a landless class. This is a normal step in the evolution of a country" [Swynnerton, p.10].

Specifically, Swynnerton expected concentration to result from individualization of tenure and the spread of market forces within the relatively egalitarian customary sector. In Njoro, by way of contrast, one would expect market forces to operate even more strongly in an agricultural sector already characterized by individual tenure and marked inequality in distribution.

In the context of contemporary Kenya, where the economic environment raises serious doubts about the suitability of land concentration as an engine for growth, Swynnerton's "normal" step is of dubious desirability.[1/] While thorough evaluation of the longer term effects of land registration and

titling programs on land concentration is beyond the scope of this paper, this paper's emphasis on the conditioning effects of farm size, market access, and wealth may help shed some preliminary light on this important issue.

SECTION 2 IDENTIFYING THE ECONOMIC IMPACTS OF TENURE SECURITY PROGRAMS: THEORETICAL CONSIDERATIONS AND EMPIRICAL COMPLICATIONS

This section develops a simple but fairly general model of farmer decision making and the impact of individual land title on agricultural productivity and performance. After illustrating the standard economic case for land titling, the framework provides the basis for a critique of an effort to identify the impact of title from a simple analysis of the Njoro data. The critique locates two specific identification problems:

(1) The identification of title effects separate from the effects of mediating factors which may be systematically or spuriously related to title status; and,

(2) The identification of credit supply-induced effects versus security or demand-induced effects.

The former identification problem (or, more precisely, the economics which create it) permits clarification of the criticism of land titling programs which was summarized in Section 1.

2.1 A Model of Title, Tenure Security, and Agricultural Productivity

Consider the following simple present value model of agricultural investment:

$$E(PV_{ik}) = \Sigma_t \{[1-\Phi_{kt}(T_k)]\pi_{ikt}(\tilde{M})\}/\{1+r(\tilde{T},\tilde{M})\}^t, \quad (1)$$

where the expected present value of return to investment project "i" on field "k" is the discounted sum of the yearly net income or profits, "π_{ikt},"

generated by the investment over each of its "t" years of duration. "Φ_{kt}" is the probability that the farmer loses claim to (is evicted from) field k in year t. In equation (1), the annual income increments are thus weighted by the probability, $[1-\Phi_{kt}]$, that the farmer will actually realize the returns from investment on field k. The term $r(\tilde{T},\tilde{M})$ is the discount rate, which will momentarily be defined more precisely as the shadow price of capital on the farm. The variable "T_k" represents the tenure status of field k and affects the eviction probability $\Phi_{kt}(T_k)$. The variables "$\tilde{M}$" and "$\tilde{T}$" are farm level variables which respectively measure market access and aggregate tenure status. $\tilde{T}$ can be considered as an appropriately weighted average of the T_k's which describe the different fields composing the farm:

$$\tilde{T} = \Sigma_k w_k T_k \,, \tag{2}$$

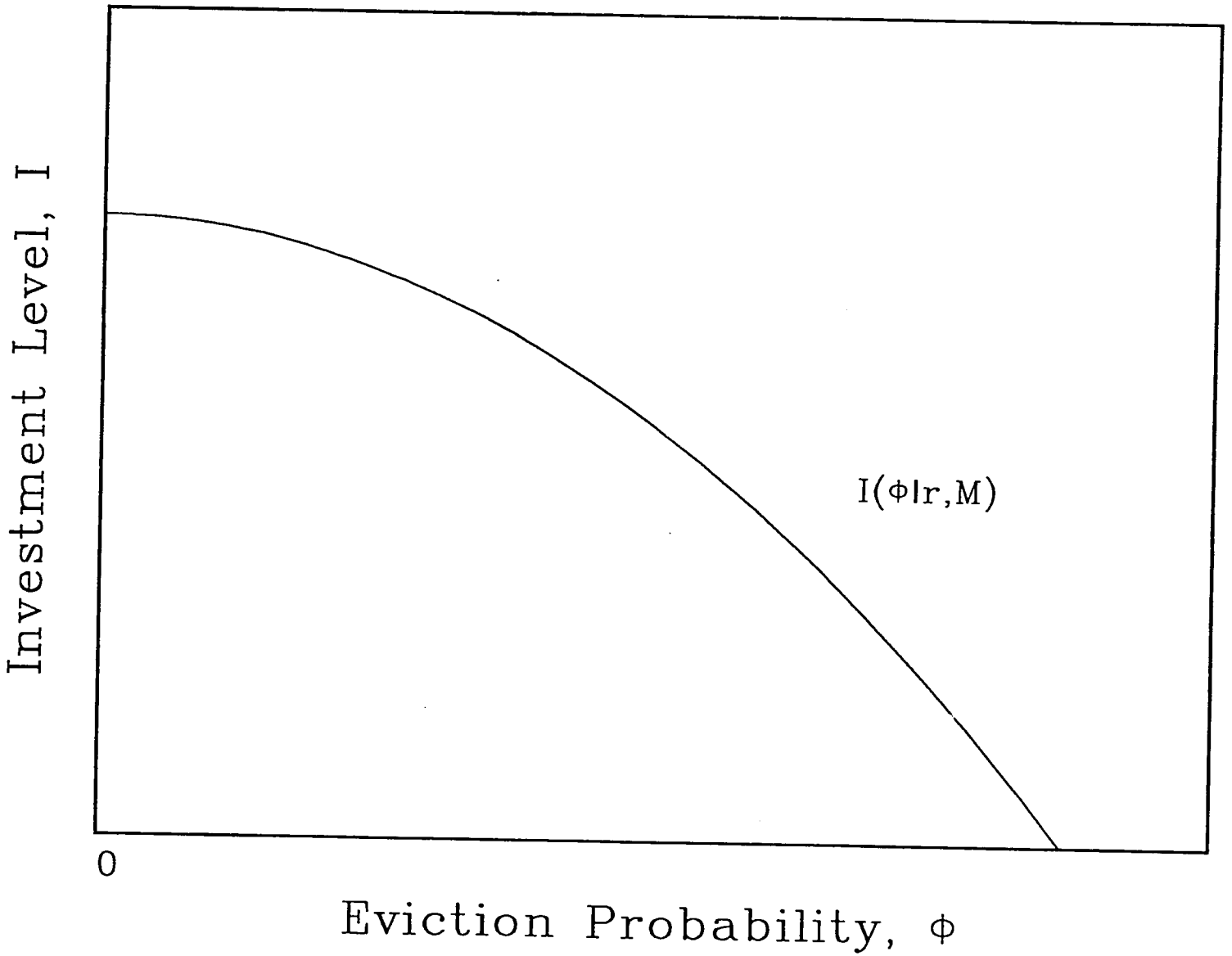
where the w_k are the weights.

Investment ik is assumed to be undertaken if

$$E(PV_{ik}) > C^*_i \tag{3}$$

where C^*_i measures the immediate direct costs of the project. Holding the farm's discount rate and market access fixed the number of projects undertaken can be expressed as a function of the eviction probability as shown in Figure 2.[2/] (It is held as a maintained hypothesis in this analysis that reduced legal exposure to eviction does imply a reduced subjective perception of the probability of eviction on the part of famers. Such a relationship is, of course, a matter for empirical investigation, and will be analyzed formally with regard to demand-induced effects of title in Sections 2.4 and 4.2.) As the eviction probability decreases, the expected present value of a given stream increases, and more projects become worth undertaking. A shift in tenure status T_k for field k, say through

Figure 2: Investment & Eviction Probability



acquisition of a secure title, will reduce the farm's legal exposure to eviction. If, as a result, the perceived probability of eviction decreases, the tenure shift will generate increased investment. The greater investment by the more secure titled land holders would be reflected over time in superior agricultural performance, and would be visible as higher yields and net returns.

2.2 A "Naive" Statistical Analysis of the Impact of Title in Kenya

A total of 100 farms in the sample are owned, 64 of them with a certificate of registered title. The remaining nine farms are operated under other tenure patterns, which include rental and borrowing arrangements. Table 2 presents a profile of agricultural activities on the basis of farms' title status. Mean values of inputs, outputs, and net returns from principal agricultural activities are summarized along with several land allocation and crop yield measures. Values are imputed at sample average prices reported for inputs purchased and outputs sold.

Titled farms can be immediately distinguished from untitled and other farms on the basis of size and cropping patterns. Titled farms are substantially larger on average than are all other farms, and allocatesignificantly less of their agricultural land to maize and beans cultivation. Maize yields differ significantly by title status, with titled farms averaging over 210 kg/acre more than untitled farms -- a gain in productivity of about 23%. Wheat production within the sample is found exclusively on titled farms.

Surprisingly, however, input levels are highest on farms without title. The total value of inputs on titled farms averages less than half of that on

Table 2. Value of Inputs and Outputs on Maize-Beans, Wheat, and Livestock Activities by Farm Tenure Status (KSh per farm acre unless otherwise indicated)

	Title	No Title	Other	All
Number of Farms	64	36	9	109
Farm Size (acres)	13.40	4.00	3.94	9.51
% Land in Maize	37.92	76.59	82.47	44.82
% Land in Wheat	20.26	0.00	0.00	16.75
Maize Yield (kg/acre)	1125.37	912.89	776.15	1052.96
Wheat Yield (kg/acre)	1269.58	--	--	1269.58
Inputs	1277.86	2701.02	2445.65	1515.51
Non-Labor Inputs	418.58	438.97	493.22	423.95
Seeds	142.91	171.85	162.82	147.62
Manure	0.42	11.36	2.26	2.00
Fertilizer	78.26	24.68	13.58	68.60
Chemicals	11.94	5.24	2.15	10.68
Livestock Inputs	177.64	211.42	299.63	186.50
Other	7.41	14.42	12.78	8.55
Family Labor*	560.10	1495.05	1071.90	707.51
Male	204.14	656.16	336.77	271.49
Female	266.56	623.97	667.15	329.91
Child	89.40	214.92	67.98	106.11
Hired Labor	165.28	696.65	834.23	261.97
Casual	85.71	274.26	287.08	118.79
Regular	79.57	422.39	547.15	143.18
Machine Services	133.90	70.35	46.30	122.08
Outputs	2671.55	2941.99	2310.49	2696.79
Maize-Beans	1056.93	1951.30	1641.28	1201.17
Wheat	845.36	0.00	0.00	699.01
Livestock	769.26	990.69	669.21	796.61
Net Returns				
Family Income	1953.79	1736.02	936.74	1888.79
Profits	1393.69	240.97	-135.16	1181.28

* In adult equivalent units: male = 1.00, female = 1.00, child = 0.50.

farms operated without title or under other arrangements. Differences in input levels appear to arise primarily from differences in family labor application, which constitutes roughly half of the value of total inputs per farm acre. (Family labor is here valued at average market wages paid to casual labor for the various agricultural activities.) Untitled farms report nearly three times the family labor applied on titled farms, and nearly half again as much as that applied under other arrangements. The differences in family labor application are related to evident differences between titled and untitled farms in average farm size and in patterns of land allocation to maize and wheat. These differences are discussed further in section 3 below.

In contrast to the general pattern of input application, fertilizer and chemical levels are highest on titled farms. This lends support to the hypothesis that tenure security in the form of a title provides an incentive towards investment in the maintenance of soil fertility.

Outputs show less variation in absolute levels, but are markedly different in terms of composition. Specifically, wheat production generates almost one third of the average value of gross output on farms with title, but does not contribute at all to the output of other farms.

Finally, two measures of net returns also vary with title status. Family income represents the per acre value of returns to agricultural activities when the value of all inputs <u>besides</u> family labor has been subtracted from gross output. Profits measure the difference between gross output and the value of all inputs <u>including</u> family labor. In effect, the family income measure imputes a value of zero to family labor, while "profits" value family labor at the market wage. The true value of family

labor, and thus of net returns to agricultural activities, thus lies somewhere between the two.

Family income, at just under KSh 2000/acre, is not significantly higher on titled farms than it is on farms owned without title (because, as noted, differences in input levels consist primarily of differences in family labor application, which is not included in this first measure of net returns). Rented and borrowed farms generate family income levels averaging under KSh 1000/acre, significantly less than on owned farms with or without title.

Lower family labor levels parallel lower output levels on titled farms, which thus earn sharply higher profits (over KSh 1150/acre more) than do untitled farms. Negative profits imputed for other farms reflect the fact that market wages, at which all labor is valued, almost certainly overstate the actual opportunity cost of family labor applied to own production.

Overall, Table 2 offers only mixed support for the general hypothesis that tenure security in the form of a registered title induces farmers to apply inputs more intensively and generate greater levels of output and net returns per acre. Tenure security may indeed provide such incentives, but these appear to be confounded by other factors which have not yet been formally incorporated. Two sets of issues in particular need to be addressed. First, factors other than title -- such as farm size, mode of access, and farmer characteristics -- also affect resource (such as family labor) allocation and productivity. And second, tenure security-related demand incentives may be constrained by supply-side restrictions, for example, as in the provision of smallholder credit. These issues are examined in subsequent sections.

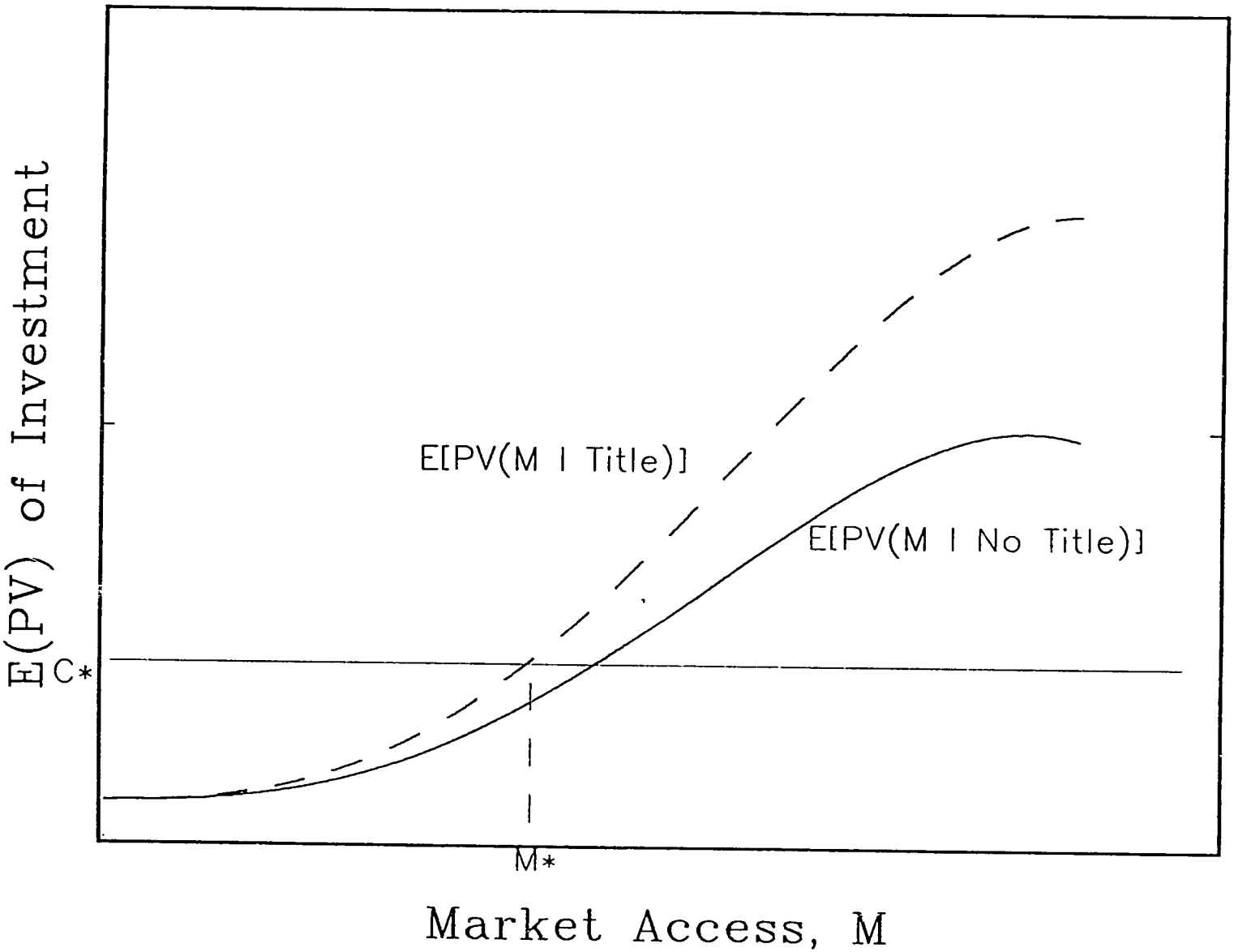
2.3 Identification Problem 1: Title Effects versus the Mediating Impact of Market Access and other Farm Characteristics

The analysis to this point has proceeded in a relatively simple (or naive) univariate fashion. It has examined the impact of land title on economic performance variables of interest in isolation from the impact (and confounding effects) of other factors which affect farm decision making and productivity. While this approach simplifies presentation of some of the basic issues in land titling, it is not a trustworthy basis for inference about the impact land titles might actually have. Further exploiting the simple model put forward in Section 2.1, this section argues that in general one would expect title status to be systematically related to other factors which influence farm productivity. Without explicitly taking these factors into account, the impact of title per se cannot be identified separately from the effects of the other factors. In addition, consideration of these factors suggests another question: "For what kind of producer do we wish to measure the impact of land title?" The fact that such a question may indeed be relevant underlies the criticism that titling programs may act as a motor of rural inequality and differentiation.

The analysis in Section 2.2 displayed a statistically significant productivity gap between titled and untitled farms. Leaving aside the question of whether the gap reflects a security-induced demand effect or a credit supply effect, a more fundamental question is whether the gap reflects an effect of title at all, or whether it simply reflects the impact of other characteristics of the farms which have title.

Figure 3 displays a hypothetical population relationship (or population regression function) between a farm's "market access" and the present value of an investment project to that farm. The term market access is used in a

Figure 3: Investment & Market Access



shorthand way here to indicate the ease and terms on which a farm unit can access capital and other commercial economic relationships. As Section 3 below demonstrates empirically, market access has a major effect on agricultural choice of technique and productivity in Kenya. In the notation of equation (1), the flow of returns to an investment project are non-decreasing in M ($d\pi/dM \geq 0$) and the shadow price of capital is non-increasing in M ($dr/dM \leq 0$). In words, the present value of, say, an irrigation investment is higher for a farm which can obtain the capital needed to buy additional seeds and fertilizer and which can sell the additional produce generated at favorable prices.

To keep matters simple, the current cost of the investment, C^*, is assumed to be independent of market access. In conformity with the model represented by equations (1-3), any farm for which E(PV) lies above the line representing C^* in Figure 3 will undertake the investment project. The lower of the two curves in Figure 3, E[PV(M|No Title)] represents the expected present value of the investment for farms without title to the field on which the investment will be made. A change in titled status for a particular field generates a given change in $\Phi_{kt}(T_k)$ regardless of market access; expected present value shifts up for titled fields as shown by the E[PV(M|Title)] curve in Figure 3. The shift in the E[PV] function for titled plots would asymmetrically favor farms with better market access (as shown in Figure 3) under a variety of conditions.[3/]

As noted, Figure 3 represents a hypothetical population relationship. True population relationships are of course not observed--data is necessary to estimate them. A question which confronts the effort to identify true title effects is whether existing titled and untitled farms are randomly

distributed over market access, M. We will argue momentarily that such random distribution is unlikely--that is, that the separation of farms into titled and untitled groups is likely to be systematically related to factors like market access.[4/]

To illustrate the importance of non-random, systematic sample separation, Figure 4 reproduces Figure 3 with the addition of hypothetical data points on titled and untitled farms (shown as "+'s" and "o's," respectively) scattered around the respective population regression functions. As drawn in Figure 4, the observed titled farm units have better market access than the untitled farms. Mean expected investment returns for the observed titled farms is $E[\overline{PV}]_T$, well above the mean for the group observed without title, $E[[\overline{PV}]]_N$. The gap between these two levels is analogous to productivity gaps in yields and net returns which were estimated empirically in Section 2.2.

What does the gap defined by the vertical distance $E[[\overline{PV}]]_T - E[[\overline{PV}]_N]$ mean? It certainly does not measure the gains in expected present value of investment which the untitled farms would experience if they were grantedland title. The average impact which titling those farms would have is given by the vertical distance labelled "A." Nor does the naively estimable $(E[[\overline{PV}]_T] - E[[\overline{PV}]_N])$ gap identify the gains that titled farms experienced when they received land titles. The vertical distance labelled "B" measures that gain. In short, the naive statistical approach does not identify the effect of land titling when there is non-random separation of farms into titled and untitled groups.[5/]

Figure 5 extends the example developed in Figure 3 to consider the population relation between net farm income and market access. As Figure 3

Figure 4: Endogeneity of Title Status

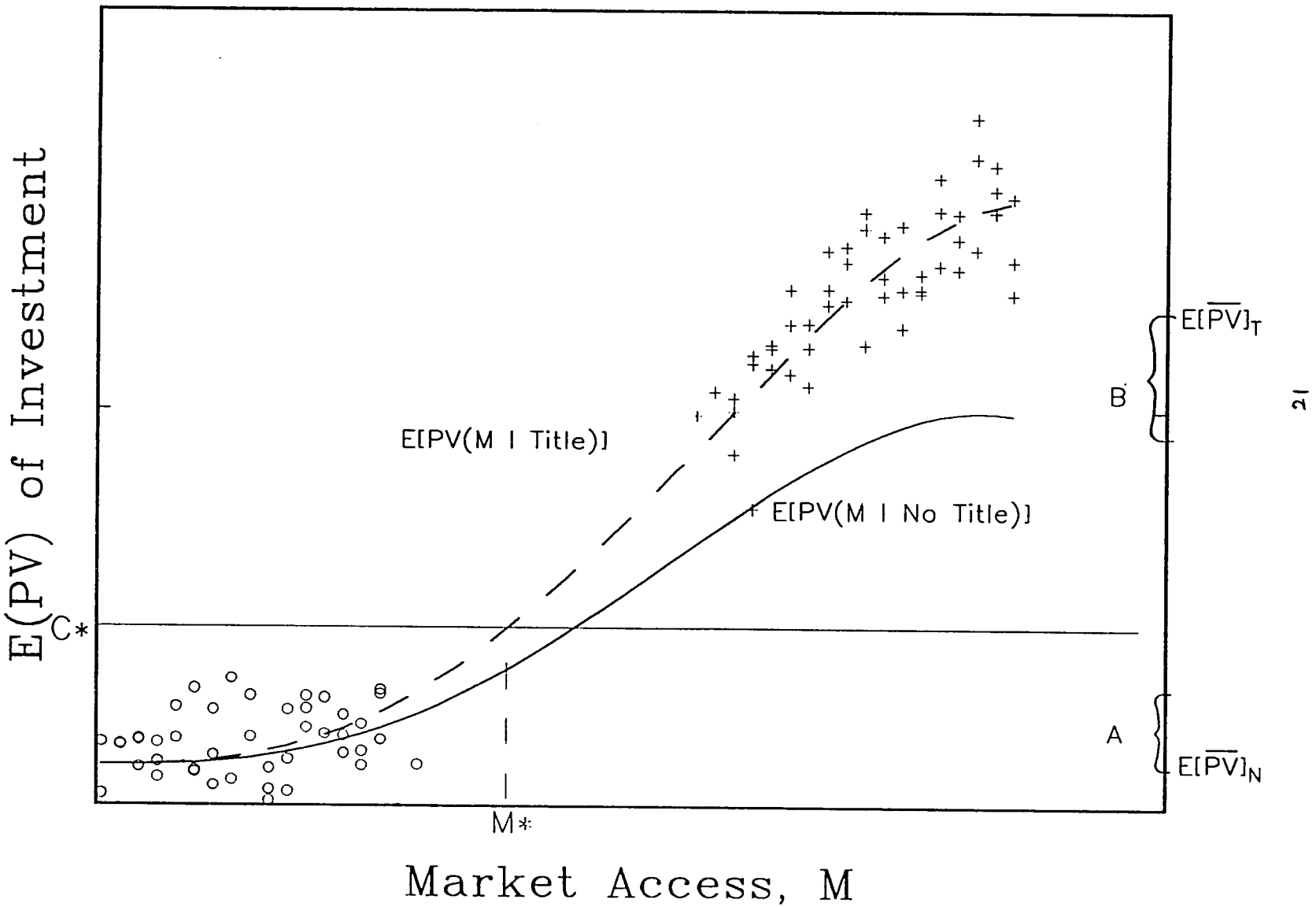
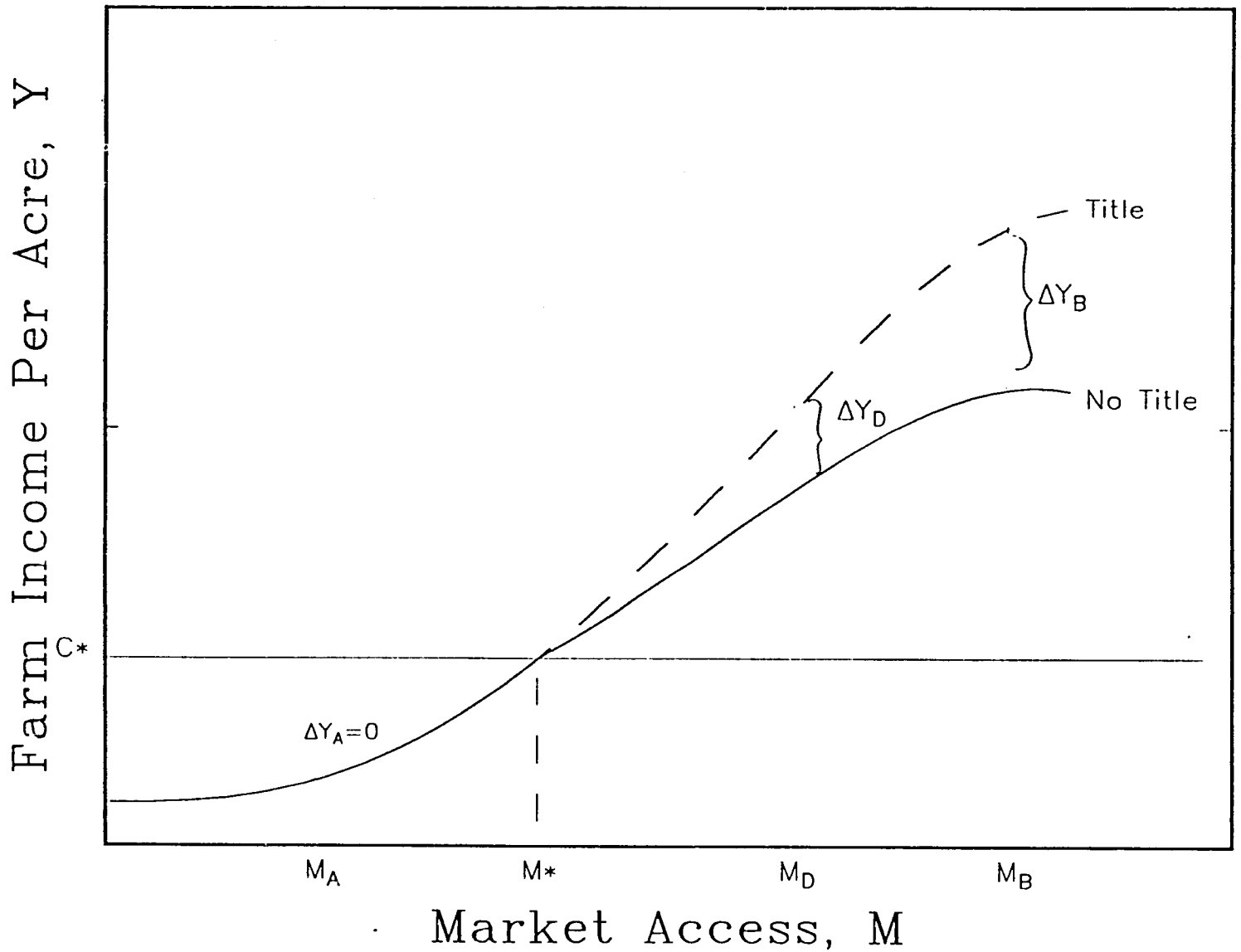


Figure 5: Farm Income & Market Access



is drawn, land titling would induce no investment for farms with market access below M^*, as the expected present value of returns even with title remains below investment cost C^*. For these farms, net farm income would be unaffected by land titling. For farms with market access in excess of M^*, net farm income would increase as the investment project is profitably undertaken.

Figure 5 thus suggests a simple reason why possession of land titles is likely to be systematically related to market access, leading to the sort of non-random sample separation shown in Figure 4:

> Returns to land title are likely to be higher for farms better situated in terms of market access or other productivity enhancing characteristics.

If title acquisition and title maintenance require real expenditures, then the better situated farms are more likely to make (or to have already made) the necessary titling expenditures, and are thus more likely to appear in any data set as titled farms.

Given these simple economics of the impact of land title, a statistical analysis which simply compares the values of outcome variables of interest between groups of titled and untitled farms will yield inadequate results. More complex analysis, which tries to statistically control for mediating factors such as market access is required. The ease with which that task can be done depends critically upon whether the mediating farm characteristics are measured and measurable. It may be relatively simple to control for market access: prices, wages, and interest rates can be readily observed. On the other hand, farming skill and land quality -- which, like market access, would enhance the returns to land titling -- are much harder to measure and to control for. "Selectivity bias" econometrics may be one

response to such latent variable problems. (See Boldt [1989] for an application of this method to land titling in Ecuador.) In any event, the likely importance of mediating factors raises the need to carefully consider the statistical identification problem.

Those same factors also raise the question "for what kind of producer do we wish to measure title's impact?" Suppose that all statistical identification problems were resolved and that the population relations displayed in Figure 5 were unambiguously known. What then is the desired measure of the impact of land title acquisition? The gap labelled "ΔY_B" measures the impact title has on income of farms which are relatively well endowed in terms of market access, $M = M_B$. The much smaller gap "ΔY_A" measures the impact on economically less well endowed farms. Farms selected at random from the entire population would, on average, experience a gain of size "ΔY_D."

These alternative measures of the gains from title have implications for program design. Should a program try to title all farms even when average gains will be small? Should a self-selection process be permitted to occur such that only the large gainers seek out title acquisition and are perhaps charged fairly high fees to cover program costs?

This differentiation in the benefits to titling thus has important consequences for the impacts of tenure reform policy. For less advantaged farmers, with size and wealth levels which leave them unfavorably situated with regard to market access, land title may be fairly meaningless. Its potential effects are overwhelmed by market access problems, leaving little incentive for title acquisition. Stronger incentives tempt the economically better positioned farmer. A title raises the value not only of his or her

initial land endowment, but also the value to him or her of the land of less advantaged neighbors. To the extent that land titling programs also facilitate transactions in land, freeing up the mechanism of potential land transfer, they may thus have the unintended consequence of boosting the relative land acquisition incentives and economic power of the already well endowed. It is this possibility which seems to underlie the criticism of land titling programs summarized in Section 1.

2.4 Identification Problem 2: Security-Induced Demand Effects versus Credit Supply Effects of Land Title

In Section 2.3 it was demonstrated that market access and other factors may obscure the impact of title on agricultural productivity which was apparent in Section 2.2. A second question to ask of the results presented in Section 2.2 is whether the measured maize productivity gap of 210 kg/acre between titled and untitled farms, for example, identifies demand effects of land title or supply effects. A shift in tenure status of field k, T_k, affects the eviction probability of field k, and thus the expected value of investment on that particular field. The inverse relationship between eviction probability and expected returns to investment reflects a "security-induced demand effect" of title by making the farmer more confident of realizing returns to investment on a particular field.

A shift in T_k also influences the aggregate tenure status $\bar{T}$ of the farm, as equation (2) shows. As seen in the denominator of the expected present value equation (1) the resulting shift in $\bar{T}$ may affect the discount rate (or shadow price of capital) r, and thereby influence investment behavior and observed productivity. Changes in investment and productivity

which occur through changes in the shadow price of capital will be called the "credit supply effects" of land title.

Conceptually, the discount rate in equation (1) represents the economic scarcity or shadow value of capital to the farm. For farms which are quantity constrained in the capital market (i.e., they cannot borrow as much as they would like at the observed interest rate), the shadow price of capital will generally exceed the market interest rate.[6/] A legally recognized, mortgagable land title is likely to enhance the farm's collateral value to the banking system. Consistent with many studies of agricultural credit (e.g. Carter 1988), the increase in collateral value may reduce the interest rate at which the farm can borrow and, more importantly, is likely to increase the amount the farm can borrow (perhaps from zero to a positive value). Either change in the conditions of credit supply will reduce the farm's shadow price of capital, r. E(PV) would increase for all projects, and incrementally more projects would be economically worthwhile and hence undertaken; observable agricultural productivity would thus increase.

Disentangling credit supply from security-induced demand effects of land title is important because the two effects have distinct welfare and policy implications. The importance of the supply effects of land title provision is underscored by the work of Feder et al. (1988) on Thailand. They conclude that credit supply effects are the "main source of greater productivity of lands owned legally" (p. 142). Supply effects indicate that collateral constraints, rather than tenure insecurity per se, inhibit agricultural production. In this situation, addressing the collateral problem directly (perhaps through the formation of mutual responsibility borrowing groups) may be the most effective policy, particularly if land titling programs are

expensive or involve some of the other tradeoffs mentioned earlier. In addition, as Roth et al. (1989) note in a commentary on Feder and Onchan's (1987) Thailand work, the aggregate social returns to land titling may be minimal if the banking system has a fixed supply of loanable funds. (In their reply to this comment, Feder and Onchan (1989) dispute the relevance of this assumption.)

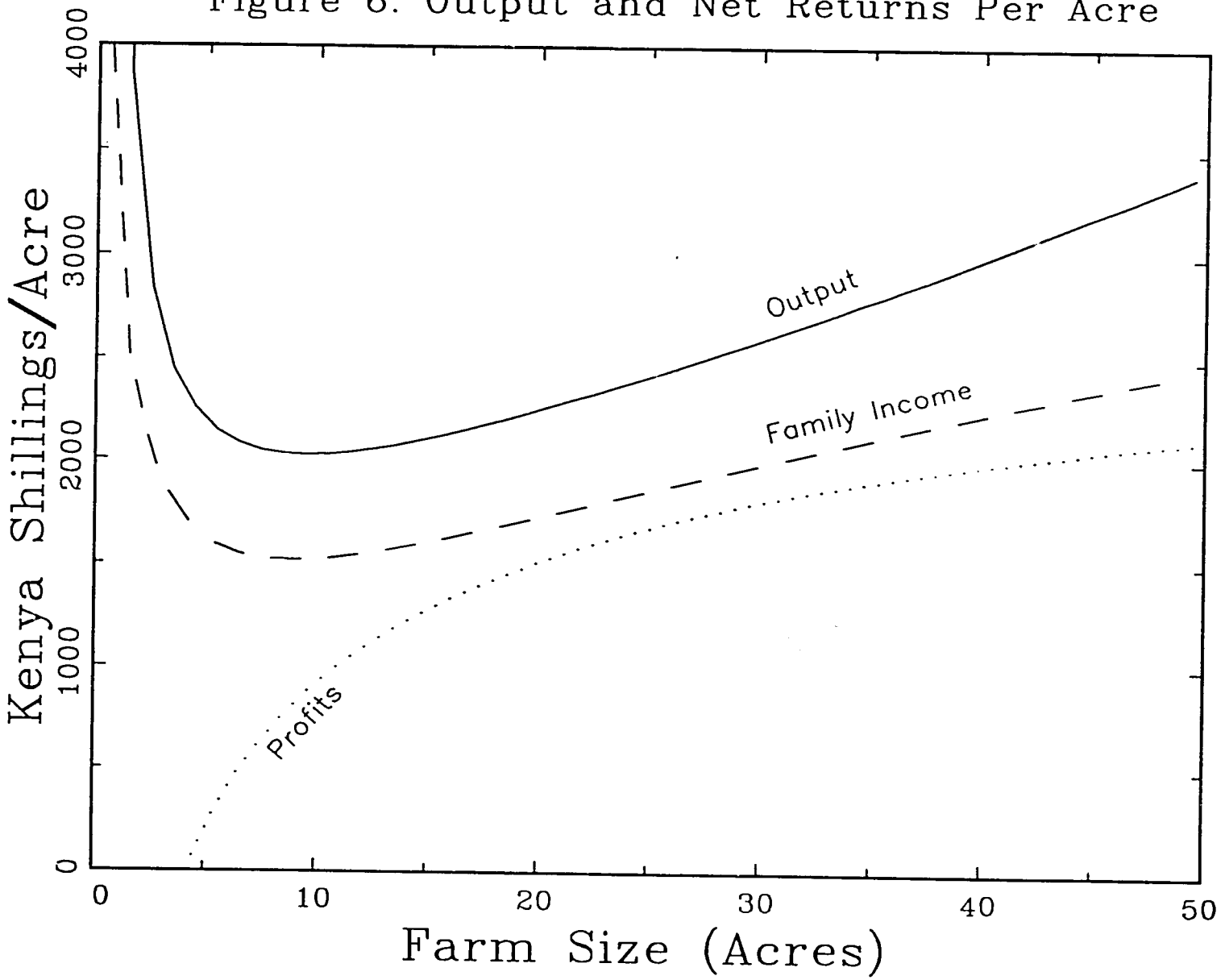
In sum, appropriate policy formation requires the distinction of supply effects from security-induced demand effects. While the latter may justify land tenure intervention the former offer a much weaker case for policy action of any sort. Such a distinction is pursued further in Section 4.2.

SECTION 3 FACTORS WHICH MEDIATE THE ECONOMIC IMPACTS OF TENURE SECURITY PROGRAMS: MULTIPLE MARKET FAILURES IN LAND, LABOR, AND CAPITAL

Tenure security considerations aside, farms within the Njoro study area display highly diverse, differentiated behavior. An indication of this diversity can be seen in Figure 6, which displays fitted farm productivity-farm size regression functions. (Appendix B presents the actual regression results.) The U-shaped Output regression curve relates the total value of output (at standardized prices) per farm acre to the size of the farm. The Family Income curve relates to farm size the per acre value of output less the value of all inputs other than family labor, while the Profit curve further subtracts the imputed cost of family labor. Beneath these economically and statistically significant farm size-related patterns lie two sorts of differentiated behavior: differentiation in choice of activity and differentiation in choice of technique.

The primary uses for land and other farm resources within the Njoro study area are maize-bean intercrop fields, pastures to support dairy

Figure 6: Output and Net Returns Per Acre

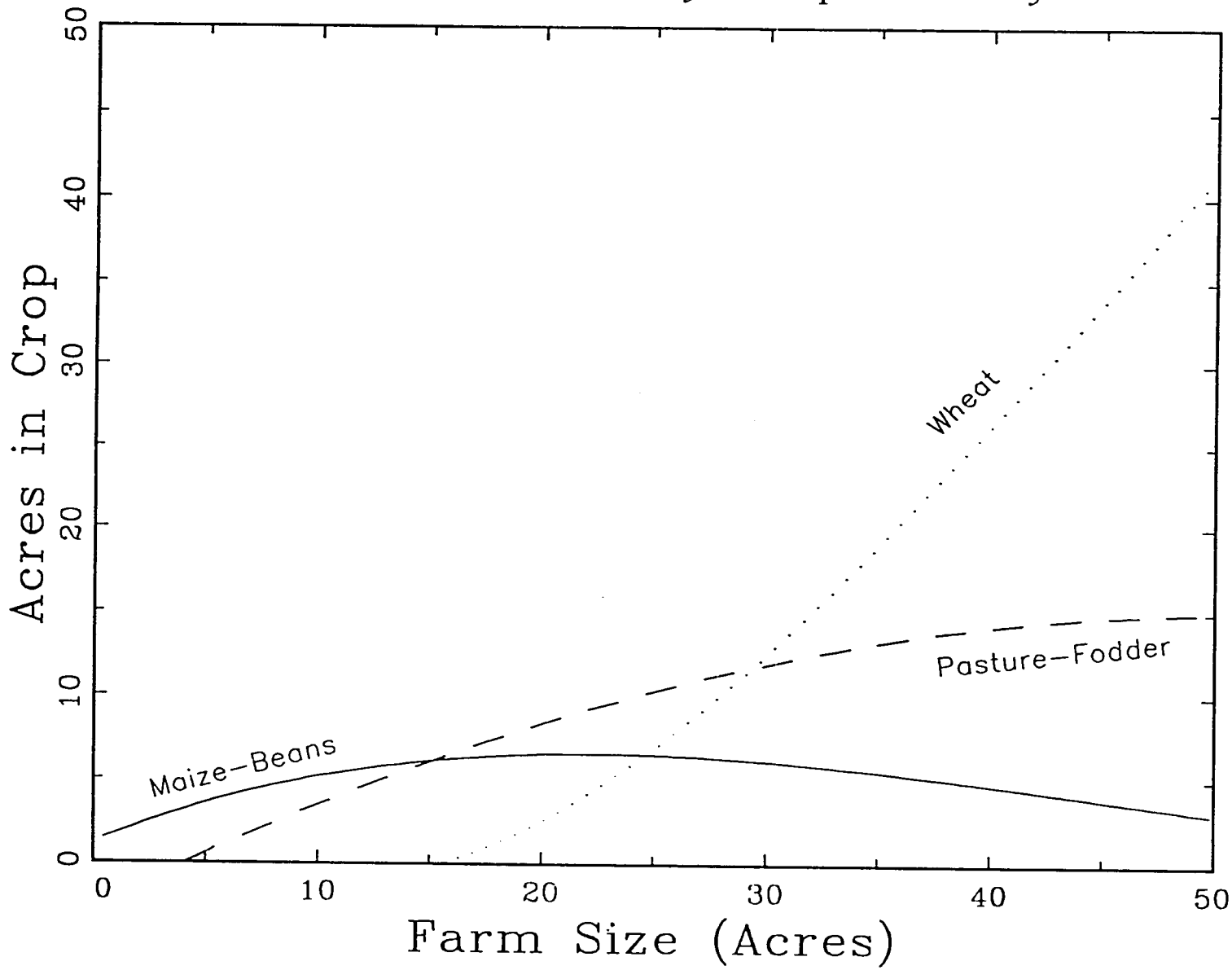


activities, and wheat fields. Figure 7 graphs the fitted regression functions which show the relation between farm size and choice of activity. All farms seem to put their first 4 or 5 acres into maize-bean production. Marginal acreage beyond that is allocated to pasture and fodder crops. Beyond about 15 acres, additional land is allocated to wheat cultivation. Of these actitivites, wheat cultivation is by far the most profitable (when inputs and outputs are valued at market prices), as Blarel et al. (1989) show in detail.

This shift to increasingly more profitable activities as farm size grows underlies part of the productivity-size relations in Figure 6. In addition, choice of technique changes radically as farm size increases. The smallestfarms use massive doses of family labor per acre in relatively unremunerative food crops, keeping up output per acre, but creating the large negative imputed profits shown in Figure 6. As farm size increases, family labor stays constant but is spread out over a larger area. The use of purchased inputs increases only slowly so that yield, total output per acre, and family income all fall. As farm size further increases, the use of purchased inputs increases dramatically, and those inputs are increasingly applied to more remunerative activities. Blarel et al. (1989) discuss these farm management patterns in more detail.

The existence of such sharp behavioral differentiation among producers is evidence of what can be called "multiple market failures" (see Jonakin and Carter 1988). First, cheap family labor, in classic Chayanovian style, appears limited in its access to remunerative off-farm opportunities. While family labor is exchanged on a casual basis among small farms there is little systematic transfer of hired labor between labor-abundant small farms and

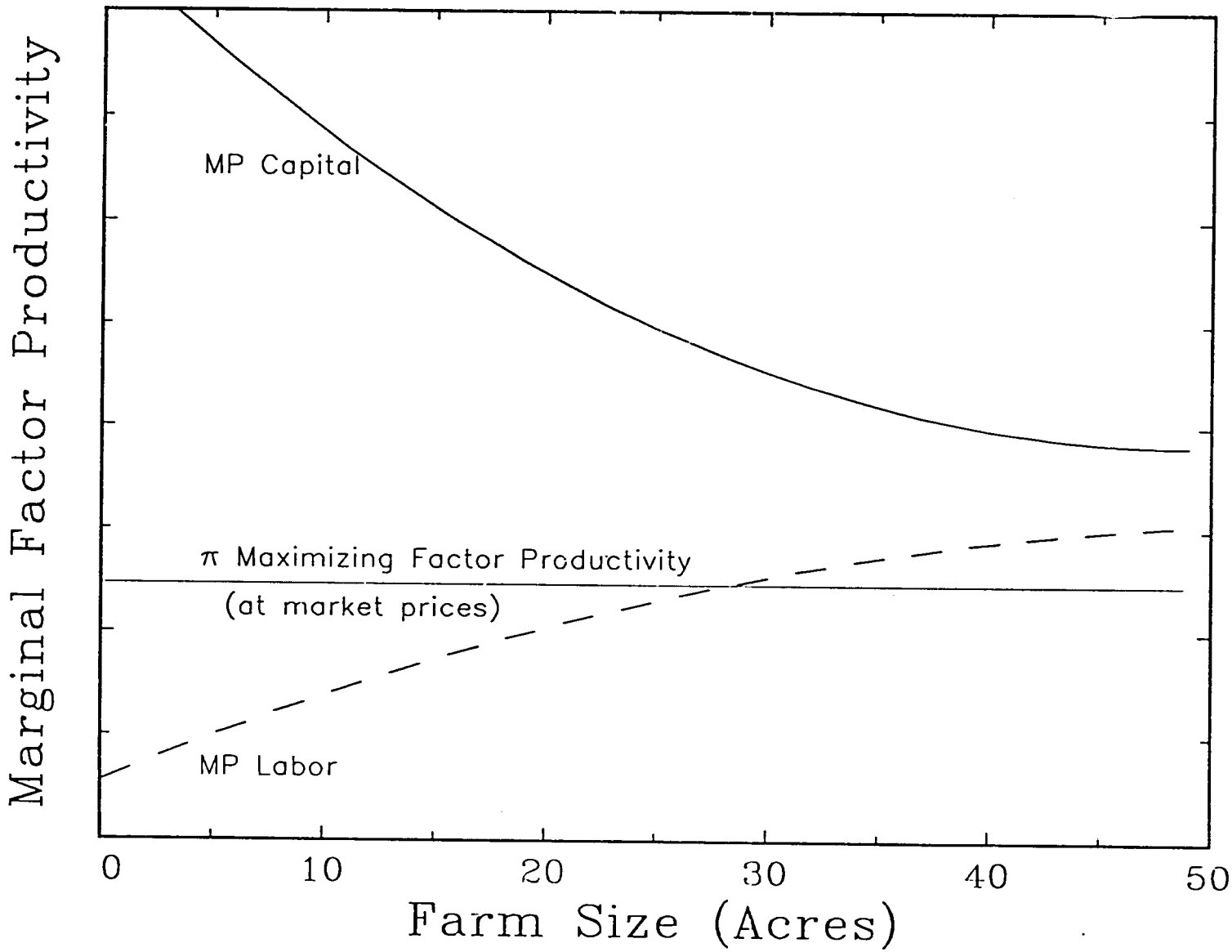
Figure 7: Area by Crop Activity



land-abundant large farms. At the same time, the failure of larger producers to transfer land to small holdings (as a way to exploit the cheap labor in residence there) indicates a second market failure -- or set of constraints -- which limits the economic capacity of the smaller units. Third, given that the smaller classes of producers choose non-working capital intensive activities and techniques, a reasonable hypothesis is that the capital market is strongly imperfect, and that access to capital is strongly stratified by farm size. Finally, and related to the hypothesis of a capital market failure, the apparent subsistence-first strategies of small and large holders may be related to imperfect risk and insurance markets. Blarel et al. (1989) discuss these market failure interpretations in more detail.

If this multiple market failures explanation of farm size differentiated behavior is correct, then the shadow prices of capital and labor ought to be strongly related to farm size, with the shadow price of labor positively related to farm size and the the shadow price of capital inversely related to farm size. Figure 8 presents the results of a simple test of these market imperfection hypotheses. Shadow prices are of course not observable; marginal factor productivities can, however, be taken as reasonable representations.[7/] After using data on maize-bean cultivation to estimate a Cobb-Douglas representation of the production technology, marginal products of capital and labor were estimated for each farm unit. These estimates were then regressed on farm size, yielding the fitted regression functions graphed in Figure 8 and confirming expectations about capital and labor market failures. Specifically, divergence between estimated shadow prices and market prices suggests that small farms are constrained in their access capital; larger farms appear constrained in their access to labor.

Figure 8: Factor Productivity by Farm Size



Market access is thus an important factor in Njoro's agricultural decision making environment, and appears markedly related to farm size. As the discussion in Section 2 argued, market access may condition or mediate the impact of land title on individual production and investment incentives. In addition, in environments where land title is not randomly allocated (and costlessly maintained) market access may also strongly influence and be correlated with those farms which are actually observed to possess title. In the Njoro study area severe capital constraints, which seem to limit expansion of small farms into more remunerative activities, may completely overwhelm any potential benefits to title for small scale producers (except to the extent that title acquisition itself has a major impact on capital access). Within this imperfect market environment, the impact or potential impact of land title is likely to be differentiated across producers, something which empirical and policy analysis must take into consideration.

SECTION 4 IDENTIFICATION OF THE DIFFERENTIATED IMPACT OF LAND TITLE WITHIN IMPERFECT MARKET ENVIRONMENTS

Titled farms in the Njoro sample differ on average from untitled farms, as the statistics in Section 2.1 showed. But, as the intervening sections have argued, it is inappropriate to simply identify title as the cause of these "naively" estimated differences between titled and untitled farms. Within the imperfect market environment which characterizes rural Kenya, other factors which may well be correlated with title status, particularly market access, are expected to have a major impact on farm resource allocation and productivity. In addition, careful consideration suggests that the impact of land titles may well be different for farmers who enjoy different degress of market access. The question of land title's impact must

be modified in order to determine what kind of farmer it is that is the subject of such impact.

Section 4.1 tries to resolve the underlying identification problem and estimate what (if any) part of the observed differences between titled and untitled farmers can be identified as a true effect of title, and what part is simply a spurious correlation between title and other mediating factors. The statistical model will be specified to test for the possibility of size-differentiated land title effects. Finally, Section 4.2 implements a methodology to distinguish what Section 2.4 called the credit supply effects of title from the security-induced demand effects.

4.1 Identifying True versus Spurious Effects of Land Title on the Economic Productivity of Njoro Agriculture

In Figure 6 three measures of farm productivity were seen to vary significantly with farm size. Do these size-productivity relationships hold up when the effects of title are incorporated simultaneously? We now consider formally the relationship between productivity and title net of the effects of farm size, which, along with mode of access, has been introduced as a proxy for farmers' access to resources and markets. This is accomplished by extending the regression analysis underlying Figure 6 to include dummy variables for title and for that particular mode of access -- the Land Buying Company -- which is expected to be most strongly associated with active market participation. (This expectation is based on observations in Njoro that various measures which may reflect market access, such as the use of commercial inputs, formal credit, and remittances, sharply distinguish farms on the basis of land buying company participation as well as of farm

size.) In addition, the potential effect of title is allowed to vary with a farmer's degree of market access:

$$\begin{aligned}(\text{Dependent Variable}) = {} & \text{Constant} + \ln(\text{FARMSIZE}) + \ln(\text{FARMSIZE})^2 \\ & + \text{TITLE} + \text{TITLE}*\ln(\text{FARMSIZE}) \\ & + \text{LBC} + \text{LBC}*\ln(\text{FARMSIZE}) + \text{error}\end{aligned}$$

where the three dependent variables -- Gross Output, Family Income, and Profits -- are evaluated in turn. This specification will indicate whether potential gains from land titling efforts are universally distributed or limited to particular groups of farmers.

The coefficient on TITLE*ln(FARMSIZE) for Gross Output (see Appendix B) are consistent with the predictions of the theoretical example of Section 2.3, suggesting that larger farms, enjoying greater market access, are indeed more likely to benefit from title effects than are smaller farms. This coefficients is not, however, significantly different from zero at acceptable confidence levels, and we will resist the temptation to claim confirmation of our earlier theoretical argument.

Rather, weak coefficients on title variables indicate that the significant differences between titled and untitled farms observed earlier in Table 2 are due not to true title effects but to the spurious correlation between title status and other important mediating factors. In general, coefficients on size and LBC dominate title in magnitude and in statistical significance for all three productivity measures. It thus appears that farm size and mode of access, as measures of producers' market access, are powerful enough to overwhelm title effects between farms in the sample. Corrected productivity relations are presented in Figure 9. Note that the "U" shape of Gross Output and Family Income and the monotonically increasing form of Profits revealed in Figure 6 are confirmed in the current expanded

specifications, indicating the importance of the relationship between farm size and productivity in general.

Figure 9 also illustrates the special productivity features which characterize farms originating from the subdivision of land buying companies. Both Output and Family Income are significantly higher on small LBC farms and lower on larger LBC farms than they are on non-LBC farms. This suggests that the higher levels of non-farm income and market access which may have enabled some farmers to participate in land buying companies in the first place are particularly beneficial to the sample's smaller farms. Profits do not differ significantly by mode of access.

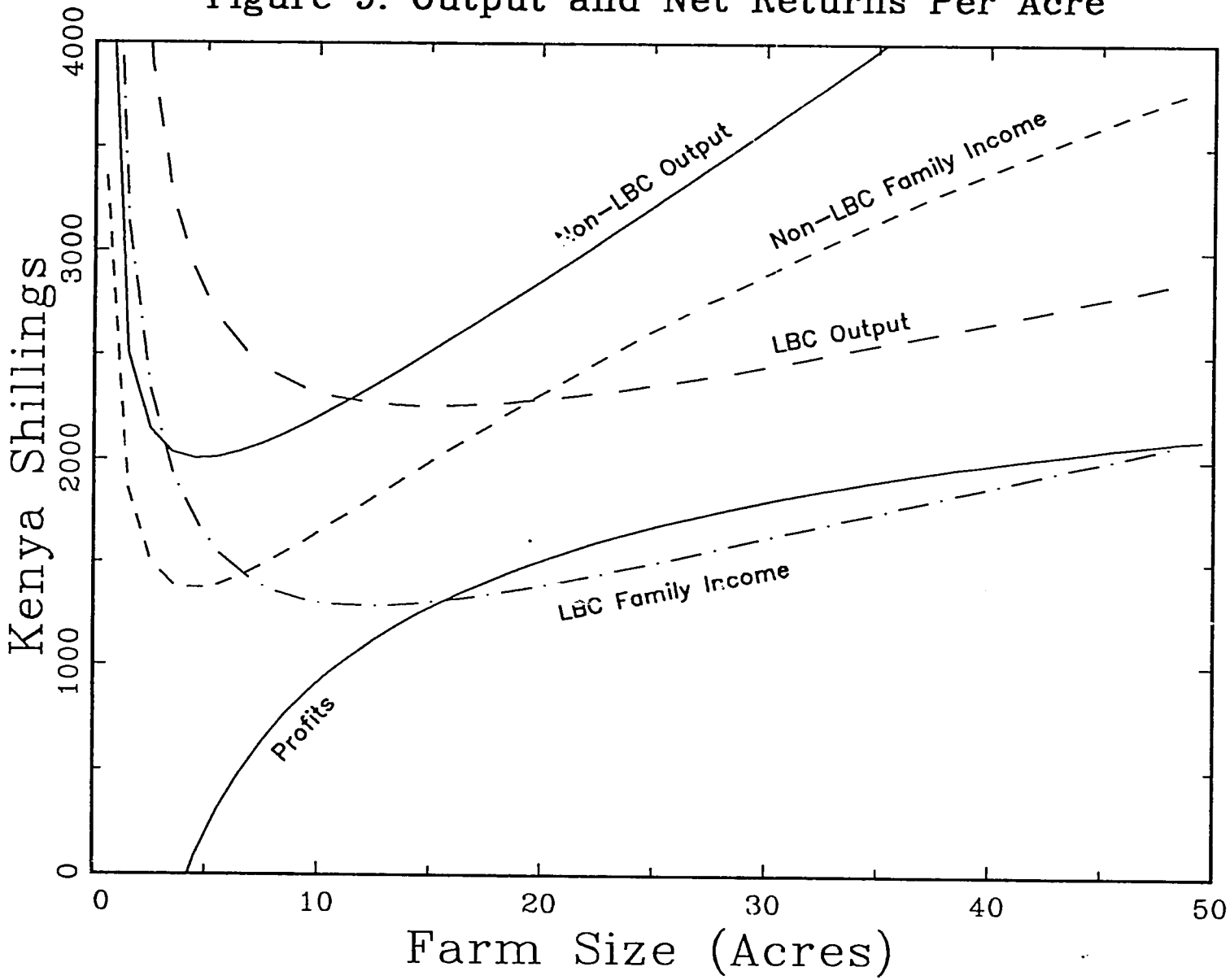
While title effects tend to be overwhelmed by the effects of differences in size and mode of access between sampled farms, it remains possible to investigate the potential role of title within individual farms, where the two proxies for market access are held constant but the title status of particular fields may vary. This possibility is pursued in the next section in an analysis of a second indentification problem raised in Section 2.4: that of security-induced demand effects versus credit supply effects.

4.2 Identification of Security-Induced Demand Effects versus Credit Supply Effects of Land Title in Kenya

While both the security-induced demand effects of land title and the credit supply effects imply greater agricultural investment and productivity, there is one key difference in their implications which can be used to separately identify the magnitude of the two effects.

Suppose a farmer receives legal title to field k. In the notation of Section 2.1 above, the receipt of title implies a change in the value of T_k and a lesser change in $\tilde{T}$. Following this change, security-induced demand

Figure 9: Output and Net Returns Per Acre



effects will increase investment and productivity only on the newly titled field k because it is only on that particular field that the likelihood of the farmer realizing returns to investment has increased. Credit supply effects will also occur with the increase in $\bar{T}$. In contrast to demand effects, however, supply effects will symmetrically increase investment incentives on all the farm's fields. This is because credit supply effects decrease the shadow price of capital, as noted in Section 2.4 above, and hence increase the profitability of any given investment on the farm.

To the extent that security-induced demand effects are operative, investment and productivity should be disproportionately high on a given farmer's titled fields as opposed to his or her fields held without title. Confirmation of demand effects would support our maintained hypothesis that reduced legal exposure to eviction actually implies reduced insecurity of tenure. If only credit supply effects occur, then for a given farm, there should be no difference between investment and productivity on titled and untitled fields. Note that in this latter scenario, investment and productivity on farms which are least partially titled could be higher than on farms which on average have a lesser degree of titling (i.e., farms for which $\bar{T}$ is less).

Exploiting the observations in the preceeding paragraphs, it is possible to disentangle potential supply and demand effects of title if there are producers whose farms are composed of fields held under different tenure status. In the Kenyan data available for this study, 26 of the sample's 109 farms cultivate multiple maize and beans fields under more than one tenure arrangement. Typically, these farms operate an owned field along with one or more fields which are rented or given.

For the subsample of 26 farms with fields under multiple tenure arrangements, the field level data were transformed as follows:

$$x^*_{ik} = x_{ik} - \bar{x}_i, \qquad (3)$$

where the x_{ik} is the untransformed observation for field k on farm i, and $\bar{x}_i = \Sigma_k x_{ik}/n_i$ is the mean across all n_i of farm i's fields. For example, if x_{ik} measures maize yield from field k of farm i, then a positive value of the transformed variable x^*_{ik} would indicate that yields on field k are higher than the average of farm i's other fields. If security-induced demand effects are systematically operative, then field level indicators of economic performance transformed according to (3) ought to be positive on average for titled fields. If only credit supply effects are operative (or if title has no economic impact), then the value of such transformed indicators should bear no relation to field-specific tenure status and the average of transformed variables would equal for titled fields.

Principal maize-beans inputs and outputs are considered in deviation form in Table 3. On average, non-labor inputs are in general applied less intensively on titled fields than they are on the untitled or other fields of the same farm. (Maize seeds, for example, are applied at a rate of 0.77 kg/acre less on titled fields than they are on farms considered as a whole.) Rented fields receive 2.11 kg/acre more than do titled fields, or 1.34 kg/acre more than does the farm overall.) Chemicals are applied more intensively on titled fields than they are on untitled or other fields. Female labor, on the other hand, is applied most intensively on titled fields. This holds true for regular hired labor as well, although more casual labor is hired to work on untitled and rented fields than on titled fields.

Table 3. Deviations from Farm-Mean Quantities of Inputs and Outputs in Maize-Beans Cultivation by Field Tenure Status (per acre of maize-beans cultivated)

	Title	No Title	Rented	Given
Number of Fields	19	16	33	4
Field Size (acres)	3.38	1.64	1.56	1.10
Inputs				
Non-Labor Inputs				
Maize Seeds (kg)	-0.77	0.10	1.34	-5.09
Bean Seeds (kg)	0.64	-2.62	0.94	-4.60
Potato Seeds (kg)	-4.33	2.08	4.26	0.98
Manure (kg)	-49.09	164.19	-14.85	-87.62
Fertilizer (kg)	-3.00	-4.32	6.92	-11.41
Chemicals (KSh)	4.18	-12.67	2.30	-12.67
Family Labor (hr*)				
Male	-1.84	6.89	-4.12	34.18
Female	20.42	-0.13	-18.72	-78.14
Child	-2.06	19.07	-7.66	6.29
Hired Labor (hr)				
Casual	-43.62	38.86	42.82	-96.34
Regular	9.36	-10.02	-5.35	-14.46
Machine Services (KSh)	3.33	-59.04	32.36	-75.91
Outputs (kg)				
Maize	-121.87	-168.51	279.29	-488.12
Beans	14.88	-17.57	-6.22	-39.58
Potatoes	-69.59	138.44	21.10	-55.83

* In adult equivalent units: male = 1.00, female = 1.00, child = 0.50.

Results for outputs are mixed as well. Maize yields are more than 400 kg/acre higher on rented fields than they are on titled fields compared to untitled fields of the same management unit. Potato yields are highest on untitled fields. Productivity in terms of beans is greatest on titled fields.

Data disaggregated by particular inputs and outputs thus provide no confirmation of the existence of security-induced demand effects of title. Are such effects visible in more aggregated measures? Title's effects on the aggregate value of inputs and outputs were tested using ordinary least squares regression analysis incorporating dummy variables for the various tenure categories. In this model

$$x^*_{ik} = b_1*(\text{owned with title}) + b_2*(\text{owned w/o title}) + b_3*(\text{rented}) + b_4*(\text{given}) + \text{error}.$$

The coefficient b_1 indicates the average deviation from farm "i's" mean level of the value of inputs or outputs (per acre of maize and beans cultivated) on fields which are owned with title. Coefficients b_2 through b_4 indicate corresponding deviations on fields which are held under other tenure arrangements. The existence of security induced demand effects should be revealed in input and output levels which are highest on those fields which are held under the most secure tenure arrangements. If registered title does indeed offer such security, we would expect to find significant productivity gains demonstrated on titled fields. Actual regression results are presented in Table 4.

Table 4. OLS Regression of Field-Specific Deviations from Farm-Mean Levels of Inputs and Outputs (KSh/acre)

Deviations in	on Title +	No Title +	Rented +	Given
Inputs	87.63	108.82	34.08	-289.86
	(148.94)	(162.30)	(113.01)	(324.60)
Outputs	-58.44	71.21	324.15	-496.66
	(220.90)	(240.72)	(167.61)	(481.43)

(figures in parentheses are standard errors)

The estimated coefficients indicate that input levels tend to be highest on owned fields (regardless of title status) and that output levels tend to be highest on fields which are either owned without title or rented. These coefficients are, however, not significantly different from one another or from zero.

Analysis of within-farm variation of input and output levels indicates that tenure security-induced demand effects, if operative at all, are overwhelmed by other factors which influence farmer decision making with respect to production. (Rented fields may, for example, differ in quality from owned fields, and be sought especially for characteristics favorable to commercially oriented production.) This failure to find any significant evidence of security-induced demand effects of land title parallels the similiar failure of Feder et al. in their study of Thailand, and indicates that provision of legal title has little impact on farmers' perceptions of the security with which they hold land.

SECTION 5 CONCLUSION AND POLICY RECOMENDATIONS

This paper began with a "naive" presentation of the apparent effects of registered land titles on agricultural productivity in Njoro, Kenya.

Subsequent theoretical and empirical analyses sought to disentangle true title effects -- whether induced by credit supply or investment demand considerations -- from those of other mediating factors. These analyses demonstrated that titles' effects are indeed overwhelmed in Njoro by factors such as farm size and mode of access to land. In particular, multiple market failures in labor, land, capital, and insurance markets contribute to the persistence of size-related patterns of technique and activity choice among smallholders. Within this imperfect market environment, the impact of land title is differentiated across producers, and market access may condition the impact of land title on farmers' production and investment incentives.

Efforts to enhance smallholder productivity via land tenure reform are thus likely to prove ineffective if conducted in a vacuum: title status appears to be less important in the determination of farm productivity than do other mediating factors together with their implications for access to markets, non-farm income, and wealth.

APPENDIX A. THE NJORO DATA SET

The data used in this paper were collected as part of a more general effort to study socio-economic constaints to agricultural productivity in the Njoro small farm sector (See Blarel et.al. 1989 for more details). This study defined its population as those small holdings of land which originated from the subdivision of large settlers' farms or from Settlement Fund Trustee Schemes. A census of ex-large farms and SFT schemes identified 103 such units, 39 of which have actually been subdivided into small holdings. For some of the 39, subdivision maps were not available; these were removed from the sample frame. The final sampling frame consisted of 24 ex-large farm/SFT units, which have been subdivided into 6,658 individual small holdings covering a total area of 46,881.5 acres.

Cost and logistical considerations dictated a sample size of 125 small holdings. (Casualties of various sorts reduced this number to 109 units for the analysis.) To avoid a wide geographical dispersion of sampled units which would have strained project interview resources, a three-stage sampling procedure was devised:

Stage 1: A total of five of the formerly large-scale units or settlement schemes was randomly selected with probabilities equal to each unit's area as a proportion of the total area in the sampling frame.

Stage 2: A total of five clusters of small holdings was randomly selected from the subdivision list of each unit selected in stage 1.

Stage 3: A total of five small holdings was randomly selected from each cluster selected at stage 2.

In practice, the above procedure was modified to permit an over-representation of the strata of "large" holdings (i.e. of holdings greater than 15 acres in size). Prior to Stage 1, the list of 24 subdivided ex-large farm/SFT units was stratified into three groups as separate sub-populations on the basis of holding size. Two ex-large farm/SFT units were selected from each of the first two groups, and one unit from the last group. This stratification ensured adequate representation of the larger holdings for later statistical and econometric analysis.

Two ex-large farms/SFT units were selected from Group 1 (plot size less than 5 acres) because that group was under-represented in the sampling frame due to constraints on sampling methodology. Given this stratification and sampling procedure, the following sample resulted:

50 holdings of size < 5 acres,
50 holdings of size >= 5 acres but < 15 acres, and
25 holdings of size >= 15 acres.

The sample selection procedure yielded a set of small holdings or Plot Units (PU's), as defined by the recorded subdivision of ex-large farms/settlement schemes into freehold plots. The PU is not, however, the final unit of observation. In some cases, part or all of a PU was rented

out, or even sold. In other cases fields were rented in, purchased, or borrowed, and brought under an integrated management strategy along with a household's PU. For purposes of survey consistency, it was necessary to establish the Integrated Farm Management Unit (or IMU, which may or may not be co-extensive with the PU) as our unit of observation. The IMU is defined as the set of fields organized as an economically interdependent unit by a single operator. In the text IMU's will be referred to simply as farms. One would expect fields within an IMU to be contiguous or nearly so; non-local agricultural lands controlled by the operator are defined as those outside Njoro Division. Income generated on non-local land is treated as a source of external non-IMU income (as are a son's remittances from Nairobi, for example).

For each IMU so defined an inventory of all cultivated fields was undertaken. Except for information on the socio-economic characteristics of the household, all data (e.g. on inputs and outputs) was collected on a field by field basis thorugh bi-weekly interviews over the 1985/86 cropping year. Data on the final sample of 109 IMUs is constructed from information collected from the nearly 700 separate fields cultivated by these units.

APPENDIX B. REGRESSION OUTPUT

Figure 6. Size-Productivity Regressions

Ln(Output/acre) on Constant, lnSIZE, and $lnSIZE^2$

--VARIABLE------	COEFF----	STD ERR-----	T-STAT-------	P-VALUE-------
Constant	8.576	0.193	44.495	2.084E-070
lnSIZE	-0.856	0.196	-4.376	2.045E-005
$lnSIZE^2$	0.190	0.046	4.097	7.425E-005

Observations:	109.000	Degrees of freedom:	106.000
Residual SS :	24.074	Total SS :	28.455
R-squared :	0.154	Rbar-squared :	0.138
Regr F-stat :	9.643	P-value of F :	9.437E-006
Std error :	0.477		

Family Income/acre on Constant, lnSIZE, and $lnSIZE^2$

--VARIABLE------	COEFF----	STD ERR-----	T-STAT-------	P-VALUE-------
Constant	3016.265	459.724	6.561	0.000
lnSIZE	-1376.827	466.358	-2.952	0.004
$lnSIZE^2$	315.466	110.581	2.853	0.005

Observations:	109.000	Degrees of freedom:	106.000
Residual SS :	1.370E+008	Total SS :	1.482E+008
R-squared :	0.076	Rbar-squared :	0.059
Regr F-stat :	4.360	P-value of F :	0.006
Std error :	1136.759		

Profits/acre on Constant, lnSIZE, and $lnSIZE^2$

--VARIABLE------	COEFF----	STD ERR-----	T-STAT-------	P-VALUE-------
Constant	-1928.707	444.528	-4.339	2.487E-005
lnSIZE	1524.031	450.943	3.380	0.001
$lnSIZE^2$	-125.765	106.926	-1.186	0.238

Observations:	109.000	Degrees of freedom:	106.000
Residual SS :	1.281E+008	Total SS :	2.070E+008
R-squared :	0.381	Rbar-squared :	0.370
Regr F-stat :	32.644	P-value of F :	0.000
Std error :	1099.185		

Figure 9. Extended Size-Productivity Regressions

Ln(Output/acre) on Constant, lnSIZE, $lnSIZE^2$, Title, Title*lnSIZE, LBC, and LBC*lnSIZE

VARIABLE	COEFF	STD ERR	T-STAT	P-VALUE
Constant	8.014	0.234	34.217	1.025E-057
lnSIZE	-0.531	0.219	-2.424	0.017
$lnSIZE^2$	0.171	0.078	2.194	0.030
Title	-0.083	0.448	-0.185	0.854
T*lnSIZE	0.032	0.251	0.129	0.897
LBC	0.961	0.259	3.708	0.000
LBC*lnSIZE	-0.395	0.143	-2.761	0.007

Observations:	109.000	Degrees of freedom:	102.000
Residual SS :	20.516	Total SS :	28.455
R-squared :	0.279	Rbar-squared :	0.237
Regr F-stat :	6.578	P-value of F :	1.841E-006
Std error :	0.448		

Family Income/acre on Constant, lnSIZE, $lnSIZE^2$, Title, Title*lnSIZE, LBC, and LBC*lnSIZE

VARIABLE	COEFF	STD ERR	T-STAT	P-VALUE
Constant	2290.911	584.638	3.919	0.000
lnSIZE	-1239.767	546.686	-2.268	0.024
$lnSIZE^2$	416.371	194.459	2.141	0.034
Title	251.083	1117.337	0.225	0.823
T*lnSIZE	-3.921	626.918	-0.006	0.995
LBC	1603.682	647.476	2.477	0.015
LBC*lnSIZE	-844.670	357.090	-2.365	0.020

Observations:	109.000	Degrees of freedom:	102.000
Residual SS :	1.278E+008	Total SS :	1.482E+008
R-squared :	0.138	Rbar-squared :	0.087
Regr F-stat :	2.714	P-value of F :	0.013
Std error :	1119.500		

Profits/acre on Constant, lnSIZE, $lnSIZE^2$, Title, Title*lnSIZE, LBC, and LBC*lnSIZE

--VARIABLE------	COEFF----	STD ERR-----	T-STAT-------	P-VALUE-------
Constant	-1470.510	571.971	-2.571	0 012
lnSIZE	1286.993	534.841	2.406	0.018
$lnSIZE^2$	-43.573	190.246	-0.229	0.819
Title	188.126	1093.128	0.172	0.864
T*lnSIZE	-283.602	613.335	-0.462	0.645
LBC	-963.019	633.447	-1.520	0.132
LBC*lnSIZE	337.489	349.353	0.966	0.336

Observations:	109.000	Degrees of freedom:	102.000
Residual SS :	1.224E+008	Total SS :	2.070E+008
R-squared :	0.409	Rbar-squared :	0.374
Regr F-stat :	11.754	P-value of F :	0.000
Std error :	1095.244		

NOTES

1/ Kenya's limited supply of agricultural land (18% of total land area is considered good agricultural land), high population growth rates (3.9% annually), and the limited opportunities outside agriculture raise important questions concerning the optimal pattern of land distribution and its effects on employment generation and output levels.

2/ This statement of course assumes that there are a range of economically and technologically feasible projects -- see Roth et al. for reservations about this assumption.

3/ In particular, this is true when $d\pi/dM > 0$ and $dr/dM < 0$.

4/ A true experimental design -- where the population of farms was randomly divided into experiment (titled) units and control (untitled) units -- would yield a situation where the simple mean difference between the two groups gives an unbiased estimate of the average effect of title.

5/ The gap does estimate without bias the difference which would exist between actually existing titled and untitled farms. The size of the gap reflects both the difference in title status and the difference in market access -- it does not separately identify the two influences.

6/ Carter and Kalfayan (1989) give a more detailed exposition of the shadow price of capital.

7/ The value of an input's marginal product represents the gain in output which would be generated by an additional unit of that input. As such the marginal product indicates the maximum value, or shadow price, that a producer is willing to pay for such an additional unit.

BIBLIOGRAPHY

Benor, D., and J.O. Harrison. 1977. Agricultural Extension: The Training and Visit System. Washington, DC: The World Bank.

Blarel, B., M.R. Carter, C. Onyango, and K. Wiebe. 1988. "Economic Constraints to Agricultural Productivity in Njoro Division, Kenya." Agricultural Economics Staff Paper No. 297. University of Wisconsin-Madison.

Boldt, R. 1989. Ph.D. Dissertation. Department of Agricultural Economics, University of Wisconsin-Madison.

Carter, M.R. 1988. "Equilibrium Credit Rationing of Small Farm Agriculture." Journal of Development Economics.

-----, and J. Kalfayan. 1988. "A General Equilibrium Model of Production Relations and Class Structure in Latin American Agriculture."

-----, and C.W. Walker. 1988. "The Evolution of Agrarian Structure in Latin America: An Econometric Evaluation of Brazil."

Coldham, S. 1982. "Land Reform in Kenya--Some Problems and Perspectives." Third World Legal Studies 1982: Law in Alternative Strategies of Rural Development. New York: INTWORLSA. 82-103.

-----. 1979. "Land-Tenure Reform in Kenya: The Limits of Law." Journal of Modern African Studies 17. 615-627.

Collier, P., and D. Lal. 1986. Labour and Poverty in Kenya 1900-1980. Oxford: Clarendon Press.

Egerton College Farming Systems Research. 1986. "A Survey of the Small Scale Farming System in Mutukanio Area, Njoro Division, Nakuru District, Kenya."

Eswaran, M., and A. Kotwal. 1986. "Access to Capital and Agrarian Production Organization." Economic Journal.

Feder, G. 1985. "The Relation between Farm Size and Farm Productivity: The Role of Family Labor and Capital Constraints." Journal of Development Economics.

Farm Management Handbook of Kenya. 1983. Volume 11.

Haugerud, A. 1983. "The Consequences of Land Reform Among Smallholders in the Kenyan Highlands." Rural Africana.

Harberson, J.W. 1984. "Structural Adjustment and Development Reform in Kenya: The Missing Process Dimension." Universities Field Staff International Reports.

Heyer, J. (?) "An Analysis of Peasant Farm Production Under Conditions of Uncertainty."

Heyer, J., Maitha, and Senga (eds). Agricultural Development in Kenya: An Economic Assessment. Oxford University Press.

IBRD. 1986. Kenya Agricultural Sector Report. Report No. 4629-KE.

IBRD. 1983. Kenya Land Issues Paper. Report No. 4391-KE.

Institute for Development Studies. 1978. "Agricultural Extension and Farmer Training." Occasional Paper No. 12. University of Nairobi.

Jonakin, J., and M.R. Carter 1987. "The Economic Case for Land Reform: An Assessment of the Farm Size/Productivity Relation and Its Impact on Policy." Unpublished Paper, Land Tenure Center, University of Wisconsin-Madison.

Large Scale Farm Sector Study. 1977. Volume 11.

Leonard, D. 1977. Reaching the Peasant Farmer. Chicago: University of Chicago Press.

Leys, C. 1975. Underdevelopment in Kenya. London: Heinemann.

Moock, P.R. 1981. "Education and Technical Efficiency in Small-Farm Production." Economic Development and Cultural Change.

Moris, J. (?) "Reforming Agricultural Extension and Research Services in Africa." Agricultural Administration Network Paper No. 11. London: Overseas Development Institute.

Njeru, E. 1978. "Land Adjudication and its Implications for the Social Organization of the Mbere." Land Tenure Center Research Paper No. 73. University of Wisconsin-Madison.

Odingo, R. 1982. "The Dynamics of Land Tenure and of Agricultural Systems in Africa: Land Tenure Study in the Nakuru, Kericho, and Machakos Areas of the Kenya Highlands." Rome: FAO.

Okoth-Ogendo. H.W.O. 1988. "An Assessment of State Responses to the African Agrarian Crisis and their Implications for Agricultural Development." Presented at the 15th Annual Spring Symposium. University of Illinois: Center for African Studies.

-----. 1982. "The Perils of Land 'Tenure' Reform." Presented at the Workshop on Land Policy and Agricultural Production in Eastern and Southern African Countries. Gaborone, Botswana.

-----. 1981. "Land Ownership and Land Distribution in Kenya's Large-Farm Areas." In Tony Killis (ed) Papers on the Kenya Economy: Performance, Problems, and Policies. Nairobi: Heinemann Educational Books.

-----. 1976. "African Land Tenure Reform." In Heyer, Maitha, and Senga (eds) Agricultural Development in Kenya: An Economic Assessment. Oxford University Press.

Republic of Kenya. 1984. District Focus for Rural Development.

Republic of Kenya. Central Bureau of Statistics. 1979. National Census Report.

Republic of Kenya. Central Bureau of Statistics. 1977. Agricultural Census of Large Scale Farms.

Rukandema, M. (?) "Farming Systems of Semi-Arid Eastern Kenya: A Comparison." East African Agricultural And Forestry Journal. (Special Issue).

Shipton, P. 1987. "The Kenyan Land Tenure Reform: Misunderstandings in the Public Creation of Private Property." Development Discussion Paper No. 239. Harvard Institute for International Development.

Trapman C. 1984. Change in Agricultural Structures: A case study of Kenyan Agricultural Development. London: Overseas Development Institute.