The Pakistan Development Review
50:1 (Spring 2011) pp. 29–45

Interlinked Factor Markets and Allocative Efficiency: Evidence from Rural West Bengal, India

ARINDAM LAHA and PRAVAT KUMAR KURI

The issue of the implication of interlinkage of factor markets on the allocative efficiency level of the farm households deserves a special attention in the light of the controversy among two distinct schools of thought: the Neoclassical and the Marxist. An attempt has been made in the paper to measure allocative and cost efficiencies of the interlinked holding *vis-à-vis* a comparable group of non-interlinked holding in the framework of Data Envelopment Analysis. Empirical evidence establishes the Neo-classical proposition that interlinked factor markets can be considered as one of the "efficiency improving institutional change" in rural agrarian economy.

JEL classification: D61, C87, Q14.
Keywords: Interlinkage, Allocative Efficiency, Rural Credit, Data Envelopment Analysis

1. INTRODUCTION

Efficiency in resource allocation has a far-reaching impact on the observed level of agricultural output. In the process of enhancing allocative efficiency[1] in agricultural production, institutional inefficiencies in rural economy need to be addressed properly. But, it is difficult to do justice to the entire web of institutions that comprise rural society. However, two notable rural institutions which play a dominant role in providing economic well-being of the rural people are: the institutions of tenancy and rural credit. It is interesting to note that the terms and conditions of the institution of tenancy are often influenced by the transactions in other non-tradable factor markets, notably labour, draft animal and credit [Pant (1983); Bliss and Stern (1982); Jaynes (1982)]. The most obvious of these is the imperfectly developed credit market in the sense that asset poor tenants can overcome a credit constraint by developing their own "access institutions". Interlinked credit tenancy transactions are considered as an important form of institutional adaptations that the institution of tenancy has modified to substitute the imperfectly

Arindam Laha <arindamlaha2004@yahoo.co.in> is Lecturer, Department of Commerce, the University of Burdwan, India. Pravat Kumar Kuri <pravatkumarkuri@rediffmail.com> is Reader, Department of Economics, the University of Burdwan, India.

[1]A firm is said to have realised allocative efficiency if it is operating with the optimal combination of inputs, given their respective prices. Technical efficiency reflects the ability of a firm to obtain maximum output from a given set of inputs. These two measures are combined to provide a measure of total economic efficiency. The term economic efficiency can be interchangeably used as cost efficiency or overall efficiency [Coelli, *et al.* (2002)].

developed credit market. Peasant rationality, in this context, substantiates the Coase theorem argument that individuals would quickly get together to eliminate any sort of distortions in the allocation of resources which, in turn, would ensure the establishment of efficient institutional arrangement [Stiglitz (1989)].

In the existing literature, there are two distinct strands of thought on the issue of the implication of interlinking of factor markets and its repercussion on allocative efficiency: the Neoclassical and the Marxist. Marxists viewed interlinked transactions as a method of surplus extraction of the tenant at the hands of the landlord [Bhaduri (1973, 1977, 1983); Bharadwaj (1974, 1985); Pearce (1983); Prasad (1973, 1974)]. It is in the interest of the landlord to extract maximum surplus from his tenants and keep them in perpetual indebtedness. Bhaduri, a noted exponent of the Marxist approach, termed this phenomenon as 'forced commerce'. In a formal model, Bhaduri (1973) argued that a landlord who also provides consumption loans to his tenant may have no incentive to adopt yield-increasing innovations if his income from his loans to the tenant goes down sufficiently to offset his share of the increased yield. Thus, in the Marxist formulation, interlinkage is seen as a weapon for improving the effectiveness of surplus extraction, and thus an inefficient deal in some sense. On the other hand, in the Neo-classical framework, market interlinkages emerge in the presence of imperfections, asymmetry of information etc., and 'it is motivated by the desire for economic efficiency, not necessarily by the desire for further exploitation of the worker' [Stiglitz (1986)]. Interlinked markets are considered to be efficient because the tenant has imperfect access to certain input markets and interlinkage is an arrangement through which the landlord (principal) makes such inputs available to the tenant. Contrary to the Marxian approach which termed interlinkage as an exploitative mode of contract motivated by the unequal relations of power, rooted in the unequal access to productive resources, in Neo-classical literature it is considered as a voluntary contract among free economic agents [Bharadwaj and Das (1975); Mishra (n.d)]. However, the possibility of exploitation cannot be ruled out in Neo-classical framework if the tenant-borrowers are pushed to their reservation income and the remaining income is appropriated by the landlord-moneylenders [Braverman and Stiglitz (1982)]. Broadly, in the Neo-classical[2] interpretation, interlinked transaction is viewed as highly 'personalised' relation between transacting agents and is evolved to ensure the 'double coincidence of wants' without which non-monetised economies tend to be unfeasible or inefficient [Cheung (1969); Bardhan (1980); Braverman and Srinivasan (1981); Braverman and Stiglitz (1982); Basu (1983)]. An interlinked system of personalised transactions may overcome the problem of inefficiencies of incomplete and imperfect markets (particularly of credit and insurance) and thus facilitates increased efficiency and higher social welfare. This can be achieved by internalising the adverse externalities (like risk aversion, low work effort, loan default etc.) of imperfect markets. Moreover, interlinking of tenancy and credit contracts can act as a screening device to identify tenant's ability and thus leads to efficient allocation of resources [Braverman and Guasch (1984)]. In this situation, the landowner provides a consumption loan to the tenant to induce him to work harder in the presence of moral hazard, advances production loans to enable the tenant to adopt improved package of practices and shares in cost to increase the intensity of input use, all aimed at getting

[2]A concise summary of Neo-classical theories on tenancy is given by Quibria and Rasid (1984).

increased agricultural yield [Braverman and Stiglitz (1982); Mitra (1983)]. Thus interlinkage can be viewed as a mechanism of increasing efficiency, higher production, and more rapid innovation—in short, higher social welfare [Ellis (1988)]. The Neo-classical school propagates for the superiority of interlinked contracts over non-interlinked ones under certain specified conditions: uncertainty [Newberry (1975)], limited liability [Newberry (1975); Basu, *et al.* (2000)], contract linearity [Ray and Sengupta (1989)], moral hazard [Braverman and Stiglitz (1982)], adverse selection [Banerji (1995)], landlord as the first mover in the sequential game [Basu, *et al.* (2000)] and monogamous tenancy[3] [Roy and Serfes (2002)]. Under this backdrop of controversy among two distinct schools of thought: the Neoclassical and the Marxist, an attempt has been made in the paper to evaluate allocative and cost efficiencies of the interlinked holding *vis-à-vis* a comparable group of non-interlinked holding in the framework of Data Envelopment Analysis (DEA).

The paper is divided into five sections. The next section deals with the data sources of the study. The methodological framework to estimate allocative efficiency is analysed in Section 3. Section 4 explores the nature of interlinked factor markets in the study area. In Section 5, an attempt has been made to evaluate the implications of interlinking of factor markets on allocative and cost efficiencies of the households by using primary data of rural West Bengal. In particular, we seek to evaluate the efficiency of interlinked households' *vis-à-vis* a comparable group of non-interlinked households. The section also deals with comparison between observed and optimal cost minimising input quantities at given levels of input prices. In addition, the section considers the association between allocative efficiency across operated farm size and participation under alternative interlinkage patterns. The concluding remarks have been presented in Section 6.

2. DATA SOURCES

The study is based on a field survey in rural West Bengal in the year 2006-07. The purpose of the survey was to explore the nature of interlinked transactions in land leasing markets and the role of credit in bringing out allocative efficiency in agriculture in West Bengal. Taking into consideration the extent and the incidence of tenancy practices, out of 18 districts of West Bengal, the district of Burdwan has been selected for the survey.[4] In the second stage, among the 31 blocks under Burdwan district, one block, namely, Raina I has been selected on the consideration of the existence of diversified nature of agricultural practices and the co-existence of varied farms of interlinked transactions. Again, block Raina I has been stratified into two distinct agro climatic zones-one, developed zone with canal irrigation and the other, underdeveloped zone with rain-fed

[3]Roy and Serfes (2002) distinguish between two concepts of tenancy: polyandrous and monogamous tenancy. Polyandrous tenancy is the institutional arrangement where a tenant works for more than one landlord whereas under monogamous tenancy one tenant works under a single landlord.

[4]The district of Burdwan comprised of 7.83 percent of total leased in land (wholly and partly) in the state of West Bengal. Only two hill districts, Darjeeling and Jalpaiguri, comprised of 12.11 and 21.28 percent of leased in area respectively are above Burdwan district. However, terms of leasing in the hill districts are distinct from other districts of West Bengal (Agricultural Census, 2000-01). Thus the choice of the district of Burdwan as our survey area is purely based on the ground of the dominant practice of land leasing for crop cultivation in the state.

agriculture. From the developed zone, the villages, namely, Saktia and Anguna have been chosen, whereas the villages namely, Dhamash and Boro have been chosen from the underdeveloped zone under the same criteria.[5] Once the villages are selected, 203 sampling units, the farm-households, have been chosen using stratified random sampling of farmers with probability being proportional to the farm size so that the sample can represent the actual proportion of all the five strata of the farmers. It is to be noted that 203 households operate over 303 agricultural holdings under alternative mode of cultivation. Our empirical analysis is restricted to 303 holdings. The farm households have been divided into five categories covering landless agricultural labourers, marginal farmers (less than 2.5 acre), small farmers (2.5–5 acre), medium farmers (5–10 acre) and large farmers (above 10 acre).

3. METHODOLOGY: DATA ENVELOPMENT ANALYSIS

In the study, we have used Data Envelopment Analysis (DEA) to examine the cost minimising behaviour and in turn, measure the allocative efficiency of farm households. In such a DEA framework, a linear programming method is used to construct a non-parametric piecewise frontier over the data, so as to measure efficiencies relative to this surface. Following Coelli, *et al.* (2002), the allocative and cost efficiencies can be measured using the Constant Returns to Scale Input Oriented DEA model.[6] In our study a multi input-multi output DEA model is used.

Following Coelli, *et al.* (2002), let us consider the situation with N decision making units (DMU). Each of the n DMUs produce Q output using V different inputs. A cost minimising linear programming problem is solved for each *DMU*. The *CRS* input oriented *DEA* model for the ith *DMU* is given by

$$Min_{\lambda, x_i^*} \quad w_i' x_i^*$$

$$\text{subject to} \sum_{i=1}^{N} \lambda_i x_{ji} - x_{ji}^* \leq 0,$$

$$\sum_{i=1}^{N} \lambda_i y_{ki} - y_{ki} \geq 0$$

$$N1'\lambda_i = 1$$

$$\lambda_i \geq 0$$

Where w_i = vector of unit price of inputs utilised by DMU_i

x_i^* = vector of input quantities of DMU_i with respect to production cost minimisation

y_{ki} = amount of output k produced by DMU_i

[5]The selection of district, block and villages are based on *a priori* information and hence it is purposive and non-random. For further details about the selection of sampling units based on primary and secondary data, see Laha (2009).

[6]This approach of non-parametric mathematical programming approach to frontier estimation was first developed by Charnes, Coper, and Rhodes (1978).

x_{ji} = amount of input *j* utilised by DMU_i

N_1 = an $N \times 1$ vector of one

λ_1 = dual variables.

The total cost efficiency (CE) or economic efficiency (EE) of the *i*th firm is measured by the ratio of minimum cost to observed cost as $CE = {w_i' x_i^*}/{w_i' x_i}$

The allocative efficiency is calculated residually by using the following relationship between cost efficiency (CE) and technical efficiency (TE) as

$$AE = {CE}/{TE}$$

The above mentioned production cost minimisation exercise can be solved by using a number of different computer programmes. In this study, we have used *DEAP*[7] *Version 2.1* for the measurement of both allocative and cost efficiencies.

4. NATURE OF INTERLINKED FACTOR MARKETS

In a rural agrarian economy, it is often seen that factor markets are not independent of one another, rather there is inter-connection among them in the sense that terms of one contract is contingent upon the terms of another. In such an interlinked deal, two or more independent exchanges are simultaneously agreed upon [Basu (1983)]. If an input dealer provides inputs to a farmer on a credit basis and the prices of input and interest rate are simultaneously agreed upon, then the input market and credit market are said to be interlinked. This issue of interlinkage has attracted much attention world-wide from anthropological enquiries[8] to various schools of development economics [Bharadwaj and Das (1975); Bardhan and Rudra (1978); Bardhan (1980); Braverman and Srinivasan (1981); Braverman and Stiglitz (1982); Basu (1983, 1987); Gupta (1987); Sarap (1991); Bose (1993); Bardhan and Udry (1999); Basu, *et al.* (2000); Gill (2000)]. Like other parts of India, several types of interlinked transactions are commonly observed in rural West Bengal [Bardhan (1984); Dutta (2002); Chaudhuri (2004); Bhattacharyya (2005, 2007)]. It is interesting to note that broadly we have come across the co-existence of two types of interlinked transactions: one-tier and two-tier interlinkages. One-tier interlinkage implies simultaneous transactions in two agrarian markets, e.g., credit-labour, credit-input and credit-product.[9] In the two-tier interlinkage, on the other hand, transactions take place in more than two markets where one landlord simultaneously acts as employer as well as producer and negotiates two types of interlinked transactions-credit-labour and credit-

[7]See Coelli "A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Programme". (CEPA Working Paper 96/08.)

[8]See Bardhan (1980) for a survey on anthropological research.

[9]In our study villages three ways of one tier interlinkage are found in practice: Credit-input interlinkage implies that the farmers take loan from the input dealer in kind and repaid in kind or cash. Credit-labour interlinkage implies that the agricultural worker takes loan from his employers and repaid in terms of his labour service. Credit-product interlinkage implies that the producer takes loan from the trader and sells at least a part of his product to him.

product [Gupta (1993); Dutta (2002)].[10] The two-tier interlinkage can be of various forms, as observed in our study area: the labour-cum-producer negotiates for two types of interlinked transactions—credit-labour and credit-product where the quantum of credit demand plays the instrumental role in simultaneous fixing of transactions. The demand for credit is attempted to be met by negotiating first-tier interlinked transactions in the form of credit-labour interlinkage, while, the unmet demand for credit is spilled over in the second-tier of interlinked transactions in the form of credit-product interlinkage. The two-tier interlinkage is also found in practices involving credit, labour, input and product markets. In our study on West Bengal, a significant percentage (61.58 percent) of sample households are involved in interlinked transactions. Credit-input interlinkage is the predominant form of one tier interlinkage in the study area; it accounts for 36 percent of total interlinked deals. This is followed by credit-labour and credit-product interlinkage. It is to be noted in this context that the types of interlinkages are sensitive to the nature of crop cultivation. Commercial crops, like potato and boro paddy cultivations, are usually associated with two-tier interlinkage where the same input dealer-cum-product seller is usually involved in input and product markets. In fact, there are three variant forms of 'two-tier' interlinkage encompassing credit, labour, input and product markets which together constitute 55.2 percent of total interlinked transactions.

The size-class distribution of various types of interlinked contract is presented in Table 1. Empirical evidence reveals that the incidence of interlinked transactions is associated with the size-class distribution of land ownership pattern. The proportion of interlinked households is largely confined to the marginal (65.57 percent) and small farmers (70.59 percent) irrespective of the types of interlinkage. The marginal and small farmers together constitute 83.2 percent of the total interlinked transactions in our study area. The size class classification of the proportion of households involved in interlinked transactions reveals that there is negative association between the farm size incidence of interlinked transactions.[11] However, the association is insignificant due to greater concentration of households in marginal and small farm categories.

It is to be noted in this context that the majority of small and marginal farmers enhance their operated land by leasing in land from the adjacent holdings of the landlords. About 87 percent of the tenants in our study area are under the category of landless and marginal farmers. This group of farmers is pre-dominantly involved in interlinked transactions. About 67 percent of asset poor tenant households borrow both for consumption and production purposes with pre-determined terms and conditions by linking their labour or crops with those of the landlord-cum-creditors. Such practices of

[10]Dutta (2002) found that same employer-cum-producer is on the one hand involved in interlinked credit-labour contract, and on the other hand, involved in interlinked credit-product contract. The producer takes loan from the trader with the commitment that he will sell at least a part of this product to him and then uses that loan either in purchasing non-labour inputs or in giving further consumption loan to the workers. So with the same producer, there is simultaneous existence of credit-product interlinkage and credit-labour interlinkage. On the basis of the empirical observation, Gupta (1993) in a theoretical paper has given an explanation of this simultaneous existence of these two types of interlinkage using the consumption efficiency hypothesis of Leibenstein (1957).

[11]The value of Pearson measure of correlation is estimated at –0.73235.

Table 1

Number of Households Involved in Various Types of Interlinked Credit Transactions

Operated Land (in Acre)	No. of House-holds	One-tier Interlinkage			Two-tier Interlinkage			Total	Proportion of Interlinked Households (in percent)
		Credit-labour	Credit-input	Credit-product	Both Credit-labour and Credit-product	Both Credit-labour and Credit-input	Both Credit-input and Credit-product		
Landless	10	5	0	0	0	0	0	5	50.00
		(62.5)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(4.00)	
0.1-2.5	122	3	20	3	25	10	19	80	65.57
		(37.5)	(44.44)	(100.00)	(86.21)	(83.34)	(67.86)	(64.00)	
2.5-5	34	0	15	0	3	1	5	24	70.59
		(0.00)	(33.33)	(0.00)	(10.34)	(8.33)	(17.86)	(19.20)	
5-10	27	0	8	0	1	1	3	13	48.15
		(0.00)	(17.78)	(0.00)	(3.45)	(8.33)	(10.71)	(10.40)	
Above 10	10	0	2	0	0	0	1	3	30.00
		(0.00)	(4.44)	(0.00)	(0.00)	(0.00)	(3.57)	(2.40)	
Total	203	8	45	3	29	12	28	125	61.58
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	

Source: Field Survey 2006-07.

Note: Figures in the parenthesis denote the percent of total interlinked transactions.

interlinked transactions in the study area are more pronounced in the fixed-rent tenancy[12] where the tenants are to bear all the costs of production. However, the limited liability clause [Basu, *et al. (*2000); Reddy (1996); Jones (1962)] is found to have empirical support; which means that in the event of crop failure the landlords come forward to forgo some of the contractual claims on the harvested crop. The limited liability clause is dominantly found in practice among the monogamous type of tenancy contract. The successful implementation of land reform programme in West Bengal has resulted in growing marginalisation of operated land in recent years. Under the circumstances, the transaction cost of acquiring lease in land constitutes a significant portion of total cost and thus, to reduce the transaction costs of negotiating with a multiple landlords, the tenants prefer monogamous type of tenancy. Over the years, they establish a relation of mutual cooperation with their respective landlords and take the advantage of limited liability in the event of uncertain outcome in agricultural production.

5. EMPIRICAL EVIDENCES: DATA ENVELOPMENT ANALYSIS

Measurement of Allocative and Cost Efficiencies

In this section, allocative and cost efficiencies of the interlinked holding *vis-à-vis* a comparable group of non-interlinked holding is measured in a disaggregated way. The allocative and cost efficiency levels have been measured at different interlinkage types (credit-input, credit-labour, and credit-product) as well as under alternative crop of cultivations (i.e., *amanswarna*,[13] paddy and all crops cultivation). Moreover, the impact

[12]Coexistence of all three tenurial practices-fixed-rent, pure sharecropping without cost sharing and sharecropping with cost sharing is prevalent in our surveyed villages. Fixed rent tenancy occupies a significant 35 percent case of alternative mode of tenurial contract.

[13]*Amanswarna* is most preferred HYV variety in terms of coverage of area in our study villages. In fact, aman paddy accounts for about two-thirds of the net cultivated areas in West Bengal [Chandra (1974)].

of interlinked factor markets on the allocative efficiency across the two agro-climatic zones—irrigated and rain-fed areas—has also been measured (see Appendix).

The Constant Returns to Scale Input-Oriented Multi Input-Multi Output DEA model is used in the study by using *DEAP Version 2.1* statistical programme. The model is comprised of data on output quantities, input quantities and prices of inputs. Output is measured by three variants: output of a particularly paddy variety like *amanswarna*, output of all paddy varieties in general and output of all crops measured as an equivalent of *amanswarna*.[14] Three important input variables are chosen, viz. total operated area, total labour (both family and hired) used and total amount of fertiliser used in production.[15] For simplicity, we assume all firms face the same input prices.

In the case of credit-input interlinkage in *amanswarna* cultivation, 82 interlinked holdings and 132 non-interlinked holdings have been identified for the study. The credit-labour interlinkage dataset comprised of 42 interlinked holdings and 172 non-interlinked holdings. Similarly in the credit-product interlinkage the dataset included 16 interlinked holdings and 198 non-interlinked holdings. The estimated means of the efficiency scores for the three selected interlinkage patterns in three different cultivation practices are depicted in the following Tables 2, 3 and 4.

Table 2

Measurement of Allocative and Cost Efficiencies under Different Types of Interlinkage Pattern in Interlinked and Non-interlinked Holdings (Amanswarna Cultivation)

Items	Credit-Input	Credit-Labour	Credit-Product
	Interlinked Holdings		
Number of Holdings	82	42	16
Allocative Efficiency			
Mean	0.856	0.916	0.880
Range	0.436-1.000	0.588-1.000	0.499-1.000
Standard Deviation	0.080	0.083	0.075
Cost Efficiency			
Mean	0.587	0.689	0.628
Range	0.216-1.000	0.261-1.000	0.42-1.000
Standard Deviation	0.110	0.106	0.103
	Non-interlinked Holdings		
Number of Holdings	132	172	198
Allocative Efficiency			
Mean	0.730	0.748	0.730
Range	0.411-1.000	0.332-1.000	0.411-1.000
Standard Deviation	0.114	0.089	0.141
Cost Efficiency			
Mean	0.455	0.455	0.449
Range	0.089-1.000	0.089-1.000	0.089-1.000
Standard Deviation	0.122	0.147	0.140

Source: Field Survey 2006-07.
Note: The statistical analysis has been made using *DEAP* statistical package.

[14]To measure a composite index of output of all crops, outputs of individual crops are converted as an equivalent of *amanswarna*. Prices of all crops are taken into account to make the necessary conversion.

[15]In the study we have considered the potential econometric problem pertaining to the endogeneity of the interlinked contract. That is, more interlinked holdings may belong to smaller farmers. As a result, the Hausman (1978) method was used to test for the endogeneity of the interlinked contract. Instruments for the test included average years of schooling and availability of formal loan. The Hausman test failed to reject the null hypothesis of exogeneity.

Table 3

Measurement of Allocative and Cost Efficiencies under Different Types of Interlinkage Pattern in Interlinked and Non-interlinked Holdings (Paddy Cultivation)

Items	Credit-Input	Credit-Labour	Credit-Product
	Interlinked Holdings		
Number of Holdings	106	49	20
Allocative Efficiency			
Mean	0.912	0.945	0.898
Range	0.495-1.000	0.854-1.000	0.566-1.000
Standard Deviation	0.082	0.039	0.109
Cost Efficiency			
Mean	0.687	0.717	0.723
Range	0.132-1.000	0.261-1.000	0.476-1.000
Standard Deviation	0.102	0.094	0.091
	Non-interlinked Holdings		
Number of Holdings	146	203	232
Allocative Efficiency			
Mean	0.858	0.874	0.858
Range	0.307-1.000	0.241-1.000	0.307-1.000
Standard Deviation	0.187	0.178	0.178
Cost Efficiency			
Mean	0.339	0.339	0.336
Range	0.029-1.000	0.029-1.000	0.029-1.000
Standard Deviation	0.141	0.149	0.140

Source: Field Survey 2006-07.

Note: The statistical analysis has been made using *DEAP* statistical package.

Table 4

Measurement of Allocative and Cost Efficiencies under Different Types of Interlinkage Pattern in Interlinked and Non-interlinked Holdings (All Crops Cultivation)

Items	Credit-Input	Credit-Labour	Credit-Product
	Interlinked Holdings		
Number of Holdings	168	70	54
Allocative Efficiency			
Mean	0.852	0.799	0.845
Range	0.257-1.000	0.182-1.000	0.278-1.000
Standard Deviation	0.179	0.179	0.190
Cost Efficiency			
Mean	0.302	0.241	0.277
Range	0.024-1.000	0.004-1.000	0.006-1.000
Standard Deviation	0.113	0.128	0.097
	Non-interlinked Holdings		
Number of Holdings	135	233	249
Allocative Efficiency			
Mean	0.735	0.630	0.535
Range	0.116-1.000	0.128-1.000	0.116-1.000
Standard Deviation	0.202	0.215	0.201
Cost Efficiency			
Mean	0.154	0.151	0.156
Range	0.002-1.000	0.002-1.000	0.002-1.000
Standard Deviation	0.133	0.131	0.172

Source: Field Survey 2006-07.

Note: The statistical analysis has been made using *DEAP* statistical package.

In *amanswarna* cultivation, allocative and cost efficiency scores are 0.856, and 0.587 respectively for the credit-input interlinked holdings, whereas non-interlinked holdings accounts for 0.730, and 0.455 respectively (Table 2). This result indicates that even when there is an efficient resource allocation (in allocative sense) in both types of holdings, the credit-input interlinked holdings are, on average, more efficient in using the production input resources than the non-interlinked holdings. This trend remains the same irrespective of which efficiency measurement concept is taken into account. In addition, all the efficiency scores of credit-input interlinked holdings tended to be clustered around the value 1. This is evident from the smaller range and standard deviation of all three efficiency scores in case of interlinked holdings than that of the non-interlinked holdings (as for example, the values of the range and standard deviation of allocative efficiency are 0.436-1.000 and 0.080 for interlinked holdings and 0.411-1.000 and 0.114 for non-interlinked holdings respectively).

Like *amanswarna*, in paddy as well as in all crop cultivation, the interlinked holdings are found to be more efficient than the non-interlinked holdings (Table 3 and Table 4). From the estimated means of the different efficiency scores of interlinked and non-interlinked holdings (credit-input, credit-labour and credit-product interlinkages), it can be found that interlinked holdings are, on average, more efficient in the allocation of resources than non-interlinked holdings. The same pattern is observed irrespective of which efficiency measures (allocative or cost efficiency) or interlinkage pattern (credit-input, credit-labour or credit-product interlinkage) is taken into consideration. Moreover, the range and standard deviation of all efficiency measurement scores for interlinked holdings have been estimated to be smaller than that of the non-interlinked holdings.

The efficiency measures pertaining to the segregated contract types also re-inforces our earlier contention that interlinked farms are more efficient than the non-interlinked farms. In credit-input interlinkage, the lowest estimated allocative efficiency level is found to be 0.852 in all crops cultivation while the highest efficiency level is 0.912 in paddy cultivation. On the other hand, in credit-input non-interlinked holdings, the lowest estimated allocative efficiency level is 0.730 in *amanswarna* cultivation while the highest efficiency level is 0.858 in paddy cultivation. Thus it is observed that the credit-input interlinkage can induce the tenant to adopt the efficient level of input use and thus can overcome sub-optimal input use resulting from risk aversion on the part of tenants in the study area. In a further comparison of estimated allocative efficiency in credit-labour interlinkage, it can be found that paddy cultivation corresponds to the highest allocative efficiency score (i.e. 0.945) in credit-labour interlinked holding, while the lowest efficiency score (i.e. 0.630) is associated with the credit-labour non-interlinked holding under all crops cultivation. A similar pattern of movement of allocative efficiency is also observed in case of credit-product interlinkage.[16]

The above evidences support the neoclassical interpretation that the institution of interlinkage is one of the allocative efficiency improving institutions and thus, in turn, has a significant impact on more rapid adoption of innovation. In this interpretation, the interlocking of tenancy with production loans can ensure that tenants adopt efficiency in resources allocation and carry out those investments, which the profit-maximising

[16]For figures relating to the allocative efficiency distributions of the credit-input, credit-labour and credit-product interlinked and non-interlinked holdings in paddy cultivation, see Laha (2009).

landlord considers most desirable. Again the interlocking of tenancy with labour service on the landlord's farm or with control over the marketing of farm output are all mechanisms which can be used by the profit maximising landlord to extract the greatest work effort from the tenant [Ellis (1988)]. In other words, interlocking markets permits a greater control on the lives of the tenants and thus the immediate virtue is reflected by greater efficiency, higher production and more rapid innovation.

Interlinkage and Optimum Input-Combinations

In the section, observed input quantities used by the farmer are compared with the optimal input quantities to determine whether farmers are allocating resources efficiently or not. The narrower the gap between observed and optimal input quantities, the more efficient is the allocation of resources. On the other hand, the greater the gap, the higher is the scope to reduce the costs of production while keeping the output constant.

The statistical software *DEAP, version 2.1*, routinely calculates cost minimising optimal input quantities at each farm level. The observed and optimal input quantities in paddy cultivation are presented in Table 5.[17]

Table 5

The Optimal Input Quantities with Respect to Cost Minimisation and the Observed Input Quantities in Paddy Cultivation

	Credit-Input		Credit-Labour		Credit-Product	
Inputs	Cost Minimising Input qt.	Observed Input qt.	Cost Minimising Input qt.	Observed Input qt.	Cost Minimising Input qt.	Observed Input qt.
Interlinked Holdings						
Land (Acre)	1.013	1.420	0.542	0.740	1.305	1.609
Labour (No/Acre)	40.498	41.925	26.25	30.323	41.923	42.588
Fertiliser(Kg/Acre)	125.283	152.89	112.235	112.493	152.885	163.51
Non-interlinked Holdings						
Land (Acre)	0.625	1.823	0.653	1.874	0.567	1.657
Labour (No/Acre)	39.973	43.89	39.97	45.40	39.97	42.45
Fertiliser(Kg/Acre)	39.508	85.89	39.505	105.545	39.505	110.71

Source: Field Survey 2006-07.
Note: The statistical analysis has been made using *DEAP* statistical package.

Table 5 suggests that in most of the cases, farmers are not using inputs in an optimal manner. It is evident that the optimal input quantities are distinctly different from the observed input quantities used by farmers. To achieve an optimal input combination, inputs should be used in lower proportion than are being applied presently. Thus there is a further scope to produce a given level of output by using the cost-minimising input ratios. Empirical evidences further suggest that credit-labour interlinked holdings are more efficient in the allocative sense than non-interlinked holdings. This is reflected in the observed differences between optimal and observed input quantities. The gap between the optimal and observed input quantities in credit-labour interlinked holding is smaller (observed and optimal input quantities are 0.542 and 0.740 respectively in land; 26.25 and 30.323 respectively in labour per acre; 112.235 and 112.493 respectively in chemical

[17]For all other tables relating to *amanswarna*, and all crops cultivation, see Laha (2009).

fertiliser used per acre) than credit-labour non-interlinked holding (observed and optimal input quantities are 0.653 and 1.874 respectively in land; 39.97 and 45.40 respectively in labour per acre; 39.505 and 105.545 respectively in chemical fertiliser used per acre).

Interlinkage and Farm-Size Efficiency

Allocative efficiency in agriculture is invariably associated with the farm-size classification of operated land holdings. An attempt has been made in this section to analyse the impact of farm size on allocative efficiency in the interlinked as well as non-interlinked holdings. The result in respect of paddy cultivation is presented in Table 6.[18] It is evident that interlinked holdings exhibit a higher level of allocative efficiency on average relative to the non-interlinked holdings irrespective of farm size. In paddy cultivation, there is significant difference in allocative efficiency estimates under interlinked holdings than the corresponding figure in non-interlinked holdings (as for example, in credit-input interlinkage the allocative efficiency estimates are 0.9026 and 0.8178 respectively in marginal holding, 0.912 and 0.8578 respectively in small holding, 0.9395 and 0.9387 respectively in medium holding). The general trend does not hold

Table 6

Measurement of Allocative Efficiencies Across Operated Land Sizes in Different Pattern of Interlinkages (Paddy Cultivation)

Operated Land (in Acre)	Interlinked Holdings		Non-interlinked Holdings	
	Allocative Efficiency	Number (%) of Firms	Allocative Efficiency	Number (%) of Firms
Credit-Input Interlinkage				
Less than 2.5	0.9026	59 (55.66)	0.8178	87 (59.59)
2.5-5	0.912	25 (23.58)	0.8578	22 (15.07)
5-10	0.9395	19 (17.92)	0.9387	24 (16.44)
Above 10	0.9257	03 (2.84)	0.9747	13 (8.90)
Total	0.9119	106 (100.00)	0.8579	146 (100.00)
Credit-Labour Interlinkage				
Less than 2.5	0.9617	41 (83.67)	0.8132	105 (51.72)
2.5-5	0.9406	05 (10.20)	0.9141	42 (20.69)
5-10	0.9444	03 (06.13)	0.9515	40 (19.70)
Above 10	–	–	0.9709	16 (07.89)
Total	0.9451	49 (100.00)	0.8740	203 (100.00)
Credit-Product Interlinkage				
Less than 2.5	0.8661	15 (75.00)	0.8087	131 (56.48)
2.5-5	0.9947	03 (15.00)	0.8846	44 (18.96)
5-10	–	–	0.9447	43 (18.53)
Above 10	0.956	02 (10.00)	0.9755	14 (06.03)
Total	0.8976	20 (100.00)	0.8586	232 (100.00)

Source: Field Survey 2006-07.

Note: The statistical analysis has been made using *DEAP* statistical package.

[18]*Ibid*, Laha (2009).

true in large operated landholdings where interlinked holding above 10 acre of operated land exhibited a lower level of allocative efficiency on average relative to that of non-interlinked holdings. No such general conclusion can be drawn in regard to the pattern of credit-labour interlinkage due to insufficient number of observations in such interlinked holdings. In other disaggregated analysis of *amanswarna* cultivation and aggregative analysis of all crops cultivation; the general trend that interlinked holdings exhibit a higher level of allocative efficiency on average relative to the non-interlinked holdings irrespective of farm size holds true. Thus it seems plausible that the inclusion of interlinked contract has a significant impact on allocative efficiency in production.

In a further comparison of estimated allocative efficiencies between two groups of farmers (interlinked and non-interlinked) across operated farm sizes, it can be argued that the allocative efficiencies increase with the increase in the size of operated land in non-interlinked holdings. Large farmers are more efficient in allocating resources in production than small farmers. In paddy cultivation, the highest allocative efficiency (i.e. 0.9747) is found for large farms in credit-input interlinked holding, whereas the marginal farm is associated with the lowest efficiency measure (i.e. 8178). The general trend of increase in allocative efficiency with the increase in operated land sizes in interlinked holding is true irrespective of which interlinkage pattern (credit-input, credit-labour, and credit-product) or which crop (*amanswarna*, paddy or all crops) is taken into consideration. However, the general conclusion does not appear to be valid when we consider the association between allocative efficiency measurement and operated land size in interlinked holdings. In paddy cultivation, medium farmers (5-10 acre) are more efficient in credit-input interlinkage (the estimated allocative efficiency measure becomes 0.9395) than other categories of farmers. In credit-labour interlinkage marginal farmers (less than 2.5 acre) are more efficient in allocating resources than their other counterparts. In credit-product interlinkage, the highest efficiency measure is 0.9947 for small farmers (2.5–5 acre) compared to other categories of farmers. A similar trend is found in other cultivations (i.e. *amanswarna* and all crops) also. In fact in the analysis of other cultivations, small and middle farmers' categories comprising 2.5–5 acre and 5-10 acre of land respectively are more efficient in allocating inputs at optimal level. In few instances, marginal farmers have a higher level of allocative efficiency than the respective other categories of farmers in interlinked holdings.

6. CONCLUSIONS

In the backdrop of the controversy of two distinct schools of thought, the Neo-classical and the Marxist, this paper deals with the implications of interlinked rural factor markets on the allocation of resources. Empirical evidences from rural West Bengal, suggest that interlinked holdings are more efficient in using the farm inputs than a comparable group of non-interlinked holdings. The conclusion remains valid irrespective of types of crop and the nature of interlinkages. Thus the econometric estimation based on Data Envelopment Analysis supports the neoclassical presumption that interlinked transactions resulted in improving the allocative efficiency in agricultural production. However, allocative efficiencies between interlinked and non-interlinked holdings are not uniformly observed across operated farm size. Allocative efficiency is invariably found to be higher in interlinked transactions than their non-interlinked counterpart irrespective of

irrigated and rain-fed areas. Interestingly, both under interlinked and non-interlinked mode of cultivation, there appears to be a gap between observed and optimal input combinations. The gap is more pronounced in the case of non-interlinked mode of cultivation. This further strengthens our earlier conclusion that interlinkage is motivated by the desire for efficient institutional arrangements in the allocation of resources in the backdrop of factor market imperfections. In the process of transformation of Indian agriculture, the role of labour in interlinked credit transactions has declined whereas the input and output market has increasingly occupied a prominent role in interlinked transactions. In this perspective, an emphasis on the availability of institutional credit is expected to reduce the dependence of such interlinked transactions as such transactions are evolved to mitigate the imperfections of certain rural institutions. Thus, the policy requirement is to make these vital inputs, like credit, available to the tenant and not to encourage interlinked markets.

APPENDIX

An attempt has been made to examine how interlinked factor markets influence the allocative efficiency across the two agro-climatic zones-irrigated and rain-fed areas[19] (Table A1). The allocative efficiency scores for the credit-labour interlinked and non-interlinked holdings in case of irrigated area have been estimated as 0.800 and 0.613, whereas rain-fed area accounts for 0.799 and 0.647, respectively. Though the efficiency level of the interlinked holdings is significantly higher than the non-interlinked holdings, however, the level of variation in efficiency in two agro-climatic zones is insignificant. Thus interlinked holdings are found to be efficient in the allocation of resources irrespective of the nature of agro-climatic zones in the study area.

Table A1

Measurement of Allocative Efficiencies under Different Types of Interlinkage Across Irrigated and Rain-fed Surveyed Area (All Crops Cultivation)

Nature of Interlinkage	Holdings	Mean	Range	Standard Deviation
Irrigated Area				
Credit-labour Interlinkage	28	0.800	0.226-0.965	0.154
Credit-labour Non-interlinkage	118	0.613	0.128-1.000	0.245
Credit-input Interlinkage	67	0.866	0.305-1.000	0.191
Credit-input Non-interlinkage	79	0.738	0.257-0.916	0.173
Credit-product Interlinkage	16	0.840	0.116-0.999	0.198
Credit-product Non-interlinkage	130	0.558	0.278-1.000	0.209
Rain-fed Area				
Credit-labour Interlinkage	42	0.799	0.321-0.999	0.190
Credit-labour Non-interlinkage	115	0.647	0.182-1.000	0.198
Credit-input Interlinkage	101	0.842	0.266-1.000	0.186
Credit-input Non-interlinkage	56	0.731	0.116-0.999	0.208
Credit-product Interlinkage	38	0.849	0.128-1.000	0.203
Credit-product Non-interlinkage	119	0.480	0.309-0.775	0.110

[19]The larger extent of two-tier interlinkage in rain-fed area is a distinguishing characteristic of our survey area. Thus the complex nature of two-tier interlinkage is predominantly a characteristic of relatively backward agriculture.

REFERENCES

Banerji, S (1995) Interlinkage, Investment and Adverse Selection. *Journal of Economic Behavior and Organization* 28, 11–21.

Bardhan, P. K. (1980) Interlocking Factor Markets and Agrarian Development: A Review. *Oxford Economic Papers* 32:1, 262–80.

Bardhan, P. K. (1984): *Land, Labour, and Rural Poverty: Essays in Development Economics.* Oxford University Press.

Bardhan, P. K. (1989) Alternative Approaches to the Theory of Institutions in Economic Development. In Bardhan (ed.) *The Economic Theory of Agrarian Institutions.* Oxford: Clarendon Press.

Bardhan, P. K. and A. Rudra (1978) Interlinkage of Land, Labour and Credit Relations: An Analysis of Village Survey Data in East India. *Economic and Political Weekly* 13 February.

Bardhan, P. K. and C. Udry (1999) Interlinkage of Transactions and Rural Development. In *Development Microeconomics* May, 110–122.

Basu, K. (1983) The Emergence of Isolation and Interlinkage in Rural Markets. *Oxford Economic Papers* 35:2, 262–80.

Basu, K. (1987) Disneyland Monopoly, Interlinkage and Usurious Interest Rates. *Journal of Public Economics* 34:1, 1–17.

Basu, K., C. Bell, and P. Bose (2000) Interlinkage, Limited Liability and Strategic Interaction. The World Bank. (Policy Research Working Paper Series, No. 2134).

Bhaduri, A. (1977) On the Formation of Usurious Interest Rates in Backward Agriculture. *Cambridge Journal of Economics* 1:4, 341–352.

Bhaduri, A. (1973) A Study in Agricultural Backwardness under Semi-Feudalism. *The Economic Journal* March, 120–137.

Bhaduri, A. (1983) *Economic Structure of Backward Agriculture.* London: Academic Press.

Bharadwaj, K. (1974) *Production Conditions in Indian Agriculture: A Study Based on Farm Management Surveys.* Cambridge: Cambridge University Press.

Bharadwaj, K. (1985) A View on Commercialisation in Indian Agriculture and the Development of Capitalism. *Journal of Peasant Studies* 12:4, 7–25.

Bharadwaj, K. and P. K. Das (1975) Tenurial Conditions and Mode of Exploitation: A Study of Some Villages in Orissa. Part I and II, *Economic and Political Weekly*, Feb., pp. 221-40 and *Review of Agriculture*, pp. A-49-A-55, reprinted in Bharadwaj (1994).

Bharadwaj, K. and P. K. Das (1975) Tenurial Conditions and Modes of Exploitation: A Study of Some Villages in Orissa. *Economic and Political Weekly* (Annual Number), 10 February.

Bhattacharyya, S. (2005) Interest Rates, Collateral and (De-)interlinkage: A Micro-study of Rural Credit in West Bengal. *Cambridge Journal of Economics.*

Bhattacharyya, S. (2007) Operation Barga, Efficiency and (De-) interlinkage in a Differentiated Structure of Tenancy in Rural West Bengal. *Journal of South Asia Development* 2, 279–314.

Bliss, C. J. and N. H. Stern (1982) *Palanpur: The Economy of an Indian Village*. Oxford: Clarendon Press.

Bose, G. (1993) Interlinked Contracts and Moral Hazard in Investment. *Journal of Development Economics* 41:2, 247–73.

Braverman, A. and J. E. Stiglitz (1982) Sharecropping and the Interlinkage of Agrarian Markets. *American Economic Review* 72:4, 695–715.

Braverman, A. and T. N. Srinivasan (1981) Credit and Sharecropping in Agrarian Societies. *Journal of Development Economics* 9, 289–312.

Braverman, A. and J. L. Guasch (1984) Capital Requirements, Screening and Interlinked Sharecropping and Credit Contracts. *Journal of Development Economics* 14, 359–374.

Chandra, N. K. (1974) Farm Efficiency under Semi-Feudalism: A Critique of Marginalist Theories and Some Marxist Formulations. *Economic and Political Weekly* 9, 32–34.

Charnes, A., W. W. Cooper, and E. Rhodes (1978) Measuring the Efficiency of Decision Making Units. *European Journal of Operation Research* 2:6.

Chaudhuri, S. (2004) *Some Aspects of Agricultural Credit in a Developing Economy.* New Delhi: Serials Publication.

Cheung, S. N. S. (1969) *The Theory of Share Tenancy.* Chicago: University of Chicago Press.

Coelli, T, D. S. P. Rao, and G. E. Battese (2002) *An Introduction to Efficiency and Productivity Analysis.* Boston / Dordrecht / London: Kluwer Academic Publishers.

Coelli, T. J. (1996) A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Programme. University of New England, Australia. (CEPA Working Paper 96/08).

Dutta, S. K. (2002) *A Study of the Interlinkage in Agriculture.* Naya Udyog, Kolkata.

Ellis, F. (1988) *Peasant Economies.* Cambridge University Press.

Gill, A. (2000) *Rural Credit Markets: Financial Sector Reforms and the Informal Lenders.* Deep & Deep Publishers Pvt. Ltd.

Gupta, M. R. (1993) A Theory of Two-tier Interlinkage in the Agricultural Credit Market. *Keio Economic Studies* 30: 2.

Gupta, M. R. (1987) A Nutrition-Based Theory of Interlinkage. *Journal of Quantitative Economics* 3:2, 189–202.

Hausman, J. A. (1978) Specification Tests in Econometrics. *Econometrica* 46, 1251–1271.

Jaynes, G. D. (1982) Production and Distribution in Agrarian Economics. *Oxford Economic Papers* 34, 346–367.

Jones, E. L. (1962) The Evolution of High Farming, 1815-65, with Reference to Herefordshire. D. Phil Dissertation, Oxford University.

Laha (2009) Land Tenancy and Rural Credit Market: A Case Study in West Bengal. PhD Thesis, The University of Burdwan, West Bengal, India.

Leibenstein, H. (1957) Economic Backwardness and Economic Growth. *Studies in the Theory of Economic Development.* New York: Wiley.

Mishra, D. (n.d.) Behind Agrarian Distress: Interlinked Transactions as Exploitative Mechanisms. E-Pov, A Monthly Newsletter on Environment and Poverty, Centre for Science and Environment, New Delhi.

Mitra, P. K. (1983) A Theory of Interlinked Rural Transactions. *Journal of Public Economics* 20, 167–191.

Newbery, D. (1975) Tenurial Obstacles to Innovation. *Journal of Development Studies* 11, 263–277.

Nhut, Q. M. (2007) Allocative and Cost Efficiency Analysis of Selected Farming Patterns Within and Outside Boundary Irrigated Systems in Tri Ton and Cho Moi District, An Giang Province (Mekong River Delta, Vietnam) (CAS Discussion Paper No 54, October).

Pant, C. (1983) Tenancy and Family Resources. *Journal of Development Economics* 12, 27–39.

Pearce, R. (1983) Sharecropping towards a Marxist View. In T. J. Byres (eds.) *Sharecropping and Sharecroppers.* London: Frank Cass.

Prasad, P. H. (1973) Production Relations Achilles: Heel of Indian Planning. *Economic and Political Weekly* 8: 19, 869–72.

Prasad, P. H. (1974) Reactionary Role of Usurer's Capital in Rural India. *Economic and Political Weekly* 9: 32–34, 1305–308.

Quibria, M. G. and S. Rasid (1984) The Puzzle of Share-cropping: A Survey of Theories. *World Development* 12:2, 103–14.

Ray, D. and K. Sengupta (1989) Interlinkages and the Pattern of Competition. In Bardhan (ed.) *The Economic Theory of Agrarian Institutions.* Oxford: Oxford University Press.

Reddy, A. M. (1996) *Lands and Tenants in South India.* New Delhi: Oxford University Press.

Roy, J. and K. Serfes (2002) Equilibrium and Inefficiency Properties of Interlinkage under Polyandrous Tenancy. May 24.

Sarap, K. (1991) *Interlinked Agrarian Markets in Rural India.* Sage Publications.

Stiglitz, J. E. (1986) New Developments in Economics. *World Development* 14:2.

Stiglitz, J. E. (1989) Rational Peasants, Efficient Institutions and a Theory of Rural Organisation: Methodological Remarks for Development Economics. In Pranab Bardhan (ed.) *The Economic Theory of Agrarian Institutions.* Oxford: Clarendon Press.

Swain, M. (1999) Agricultural Tenancy and interlinked Transactions-II: Neoclassical and Marxist Approaches. *Economic and Political Weekly*, September 18, 2752–2758.

Swain, M. (1999) Agricultural Tenancy and interlinked Transactions-I: Neoclassical and Marxist Approaches. *Economic and Political Weekly*, September 11, 2657–2666.