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The Farm Size -Productivity Debate Revisited

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The relationship between land size and productivity is a hotly debated topic in agricultural economics. Some argue that there is a Direct Relationship (DR) between land size and productivity, some argue for an Inverse Relationship (IR) while some researchers believe that there is no relationship as such, or is different for different land size ranges. Studying the IR-DR debate becomes important if policy makers want to improve agricultural productivity through land reforms. The area under cultivation is constrained by an increasing demand for land needed for industrialization, urbanization and infrastructure. Thus a higher agricultural production would require a higher agricultural productivity. If the IR does indeed exist , then land ceilings, redistribution after breaking up Large Farms (LFs) into Small Farms (SFs) and various other policies which support smallholders will gain backing on efficiency and growth reasons , besides equality concerns.

Introduction

The IR-DR debate was prefigured by classical economists and their political colleagues. IR believers such as Mill, Thornton and de Tocqueville argued that the IR provided a presumption in favor of small-scale farming, and thus land reforms in nineteenth-century Ireland and India. Others counter claimed a DR (Direct Relationship), providing a presumption against land reform. Right wing DR believers such as Torrens and Nassau Senior , looked to markets to shift land to large farms and supported the Enclosing Act in Britain while left wing DR believers, including Lenin and
J. S. Mill, advocated large scale co-operative farming.

The debate revived with the evidence for the IR in the Indian Farm Management Surveys of the 1950s and the Inter-American Committee for Agricultural Development's reports on seven Latin American countries. Sen's 1962 article is an often cited evidence for IR, where he stated that "by and large productivity per acre decreases with the size of the holding". The Farm Management Studies database was of a aggregated nature, and critiques were quick to point out that the IR cannot be considered as well-established unless it is tested on the basis of individual farm data. Hanumantha Rao (1966) found the presence of IR even on disaggregated data , which became less marked after accounting for irrigation. The literature supporting IR is impressive, with influential work being done by Khusro (1964, 1973); Sen (1964, 1975); Mazumdar (1965) ; Saini(1969); Bardhan(1973); Berry & Cline(1979) ;Bhalla (1979); Chaddha (1978);Ghose (1979);Subbarao (1982) ;Carter (1984);Bhalla and Roy

(1988);Rosenzweig & Binswanger(1993); Krishna(1995), Chattopadhyay & Sengupta(1997);Dyer(1998),etc.
Ashok Rudra (1966) challenged the IR as a "stylised fact" of rural development, and using the same data set as Sen pointed out that there is no systematic relationship between yield per acre and farm size. He recognised that IR does not exist universally for all areas or all land size categories. His 1968 paper which was based on a sample of 20 villages led him to conclude that "at least for these sample observations the relation between yield and farm size is spurious".

A.P. Rao(1967) and Krishna Bhardwaj(1974) held the nuetral view: that productivity does not have a statistically significant relationship to land size.

The debate over this period can best be summarised by Rudra and Sen's 1980 paper, in which they agree that the land size-productivity IR is not a universal phenomenon in Indian agriculture, and in the studies conducted so far is "more frequently confirmed than rejected".

The IR hypothesis has been tested in other countries too. Berry and Cline (1972) established that the land productivity was at least twice in Columbia, Brazil, India , Malaysia of SFs as compared to LFs. Cornia's 1985 work finds a strong IR in 12 of the 15 countries he studied. A statistically significant IR was found by Heltberg (1998) in Pakistan and Hossain(1974) in Bangladesh.

These earlier studies are often attacked on the grounds of being too oversimplified and prone to various statistical biases. Barbier(1984) writes "One is thus left with the impression that a number of authors feel somewhat embarrassed about the restrictive framework of analysis which they used: to compensate for this weakness and to avoid being accused of any kind of 'Ricardian Vice', they show much more flexibility when they venture into formulating some policy conclusions when they set up their framework of analysis.Yet it is not very scientific since the policy qualifications do not really follow from the analysis proper but seem to 'fall from the sky' at the last moment ".

Most recent researchers have moved on from testing the presence or absence of IR and are more focussed on assessing causation (while taking IR to be present in developing countries). Some recent works like Chand et al (2011) which use more sophisticated models and econometric techniques have also confirmed the IR. Wang et al (2015) use a production function approach and find the presence of IR in rice cultivating farms in Allahabad, after controlling for farmland quality, imperfect factor markets and farm measurement error. Matchaya(2007) finds an IR in Malawi using OLS with heteroskedasticity consistent covariance matrix, after ruling out endogenity.

Thus the general consensus is that IR is usually present in developing countries, as most of the evidence seems to support such a relationship.

Some Trends in India

The area under non-agricultural uses has increased by 11% in the last decade in India. A recent survey published by the International Rice Research Institute suggests that the arable land per capita would decrease to 0.09 hectare by 2025. Therefore, the production decisions and input use of farmers at various land sizes need to be understood for an effective agricultural strategy.

There are about 500 million farms globally,85% of which are SF's (Less than 2 hectares). The majority of these SFs are located in Asia (87%).

Data from the latest Agricultural Census shows that between 1970-71 and 2010-11, the average landholding size declined by about half from 2.28 hectares to 1.16 hectares in India. (Table 2) Landholding structure is moving towards small and marginal holdings. Put together, they constitute 85 per cent of number of operational holdings (in 1970-71) and 44 per cent of the
total operated area (21% in 1970-71). (Table 1)

Table 1: Distribution of Number of Holdings and Area Operated in India

Sl. No.	Size Group	Number of holdings (in million)	Area operated (in million ha.)	Average operated area per holding (ha.)	Percentage of holdings to total holdings	Percentage of area operated to total area
1	Marginal (Below 1.00 ha.)	92.4	35.4	0.38	67.04	22.25
2	Small (1.00-2.00 ha.)	24.7	35.1	1.42	17.93	22.07
3	Semi-Medium (2.00-4.00 ha.)	13.8	37.5	2.71	10.05	23.59
4	Medium (4.00-10.00 ha.)	5.9	33.7	5.76	4.25	21.18
5	Large (Above 10.00 ha.)	1.0	17.4	17.38	0.73	10.92
6	All holdings	137.8	159.2	1.16	100	100

Source: Agricultural Census 2010-11

The area under irrigation has consistently been negatively related to the land size. While 50% of the marginal holdings were irrigated in 2000-01, the same figure stands at 31% for LFs. Similarly, fertiliser application is more intensive in SFs than LFs. Marginal farm holdings use 175 kg/hectare fertiliser, 2.5 times more than large farms. The size advantage persists both for irrigated as well as unirrigated land. The area under High Yielding Varieties of Seeds was 55% under small and marginal farmers in 1996-97 . This has increased to 68% and 72% respectively in 2000-01. On the

other hand , coverage of HYVs remains significantly lower for LFs (47% in 2000-01, 42% in 1996- 97). Thus, SFs are more input intensive than LFs in India.

Table 2:Size Group wise distribution of Average Holdings in the country

S.No	**Size Groups**	**1970-71**	**1976-77**	**1980-81**	**1985-86**	**1990-91**	**1995-96**	**2000-01**	**2005-06**	**2010-11**
1	Marginal (Below 1 ha.)	0.40	0.39	0.39	0.39	0.39	0.40	0.40	0.38	0.38
2	Small (1-2 ha.)	1.44	1.42	1.44	1.43	1.43	1.42	1.42	1.38	1.42
3	ni-Medium (2-4 ha.)	2.81	2.78	2.78	2.77	2.76	2.73	2.72	2.68	2.71
4	Medium (4-10 ha.)	6.08	6.04	6.02	5.96	5.90	5.84	5.81	5.74	5.76
5	Large(Above 10 ha)	18.1	17.57	17.41	17.21	17.33	17.21	17.12	17.08	17.38
	All Size Classes	2.28	2.00	1.84	1.69	1.55	1.41	1.33	1.23	1.16

Source: Agricultural Census 2010-11

The cropping intensity is also observed to be higher for smaller holdings, and the size advantage has continued in the all the periods. Regarding the cropping pattern; cereals are the dominant crop group in smaller landholdings while higher value crops like spices, pulses, vegetables, oilseeds occupy a higher percentage of cropped area in larger landholdings.
Table 4 shows the presence of an IR between farm size and productivity. The value of output is more than thrice for the <0.4 hectare category as compared to >10 hectare.
Table 3:Input Intensity vs Land Size

Year	Marginal	Small	Semi Medium	Medium	Large	All
Area under Irrigation (in %)						
1980-81	40	33	29	24	16	27
1990-91	44	36	33	30	22	33
2000-01	51	39	37	36	31	37
Fertilizer Consumption(in Kg per Hectare)						
1981-82	55	48	42	36	27	40
1991-92	99	85	77	68	54	76
2001-02	175	129	112	95	68	119
Share of Area under HYV(in %age)						

1996-97	59	55	54	53	42	54
2001-02	72	68	65	61	47	64
Cropping Intensity						
1981-82	134	128	125	120	116	124
1991-92	137	130	124	121	118	126
2001-02	139	128	126	125	121	128

Source: Agricultural Census, Input Survey

Table 4:Inverse Relationship between land size and productivity

	Value of Output (in Rs)	
Farm Size	Per Capita	Per Hectare
0.01-0.4	965	25173
0.4-1	2364	18921
1-2	3801	16780
2-4	6734	15091
4-10	10588	13564
>10	16782	7722
All	3143	15426

Source: Reproduced from Chand (2011)

Why does an IR exist?

Understanding the IR has important policy implications, especially for land reforms. Land redistribution would lead to an increase in the average agricultural productivity only if small plots are intrinsically more productive than large pieces of land, or are linked to factors indissolubly associated with size. But if the IR exists due to credit and labour market constraints then different policies need to be pursued. Thus it becomes important to take a look at the reasons for the IR in developing countries. Higher yield per hectare on SFs can be explained by the following 4 factors :

(1) higher percentage of farm area is cultivated

(2) higher cropping intensity on cultivated land

(3) higher-value cropping pattern

(4) higher yields per acre for a given crop.(due to more intensive input application)

(1) has been observed for Latin American countries, while (2) and (3) are present in Bangladesh. In India, the IR is mostly realised through (4). (Rao,1975; Subbarao, 1982;Federer ,1985)

The reasons for the existence of an IR given below are not mutually exclusive, and often

overlap.

1) Labour Market Dualism

This argument was popular in the 1950s and 60s. Dualism here is the distinction between hired labour and casual labour. Hired labour is employed according to the marginal product rule, but SFs typically use family labour, and the returns are averaged over family members. Land-rental market imperfections make the absorption of surplus labour of SFs difficult, and hence they employ labour till zero marginal productivity. Therefore, the labour per hectare and the associated complimentary inputs like fertilizer,etc. would be higher in SFs and result in a higher yield per hectare, but a lower profitability. A more appealing form of labour-market dualism asserts that family labour has lower opportunity costs than market wages due to imperfections in the labour market and thus labour is over-applied in SFs (Barrett 1996;Sen, 1962). Perhaps, too,"peasants' 'proclivity to labour'– in Marxist language, 'self-exploitation' or 'the lash of poverty' – drive them to work on their own account more intensely, and for less benefit, than they would accept if working for others". (Lipton,) The evidence for the same is shown by Carter (1984). Feder (2001) explains the IR in the context of a principal agent model: Family labour has stronger incentives to put in more effort as they get to directly share the farm proceeds and can expect to inherit the farm as well. On the other hand, LFs require hired labour who are more prone to shirking (the moral hazard problem).

2) Management Costs

Variable Costs for a farmer are of two types: Production costs (cost of physical labour, capital such as ploughs, and working inputs such as fertiliser) and Management costs(the cost of selecting and supervising factors, marketing output). The production cost per unit of output has been found not large or pervasive enough to explain the big balance of evidence for strong IRs in developing- country agriculture, or the corresponding DRs in developed-country agriculture. The main explanation is management cost per unit of output. SFs have lower unit management costs associated with labour and marketing of output as most of the output is self-consumed. This argument is closely linked to the labour dualism argument.

Labour linked management costs are lower for SFs partly because they use family labour , and thus there are no search/ screening costs involved. Even with hired labour on SFs, family members are nearby which makes supervision easy. Raghbendra et al. (2000), Berry and Cline (1979), Bhalla (1979), Bardhan (1973),Feder (1985), Eswaran and Kotwal (1986), and Taslim (1989 provide supporting evidence to this theory.

3) Risk

SFs, who strongly overlap with poor farmers are more risk averse than LFs.(Binswanger, 1980) .A first glance may suggest that this risk averseness may weaken the IR by SFs decreasing the input intensity (committed input costs are certain while output is not).However theoretical and empirical work suggests that this is not the case. Srinivasan (1973) shows that output risk can lead to an IR as risk-reducing inputs (irrigation, pest control, etc.) would be encouraged. Even risk neutral inputs could be over applied due to food security stress. SFs , expecting to be net food buyers will to work harder, so as to grow more food, and reduce exposure to consumption price risk. The strong IR observed in Madagascar is partly due to price risk (Barrett 1996)

4) Measurement Errors

The IR could be spurious emperical observation due to measurement errors. This would happen if land size is positively correlated with the measurement error. Farmers especially at the top end tend to over-report their landholding size, as it is considered a measure of prestige and political power. But IRs persist after allowing for unbiased measurement error (Kimhi ,2006; Carletto 2013).another kind of measurement error is that SFs tend to under-report their output, as most of it is self- consumed. This bias would suggest that observed IRs are weaker than true IRs.

5) Missing Variables:

Both SFs and Lfs are heterogeneous.Simple measures, which regress annual farm output per hectare against farm size, miss out this. Land Redistribution in favour of SFs will not raise average productivity if the 'missing variables':

1) Affect output directly

2) Are correlated with land size, and somehow favour SFs more than LFs

3) Are not due to the result of farm size itself

Sen notes that the the differences in the land size itself might be 'incidental' and merely correlated with the system of farming i.e. whether it is wage-based or family based.
Assuncao and Ghatak (2003) find that farmer self selection combined with credit market imperfections and Constant Returns to Scale can generate IR (High skilled peasants ending up cropping SFs). Most of the literature revolves around Soil Quality, which is the omitted variable most often proclaimed to undermine the IR. If SFs have higher land quality then the move from LFs to SFS and if this is what explains IR then land redistribution won't have any productivity impact. Stiffe (2003);Bhalla &Roy (1988);Newell et al (1997) observe that LFs are typically associated with a lower land quality in Madagascar,India and Gujarat respectively. Bhalla and Roy confirmed the presence of IR but noted it weakened and in many cases disappeared once soil quality variables were introduced in the regression equations. On the other hand Barett et al found that the usually omitted soil quality measurements explain only a very small fraction of the IR in Malagasy.Similar conclusions were reached in Pakistan and Java.Hence, soil quality can explain some, but not all of the IR. It is important to note that higher land quality may be inherent, or could be due to farmer actions such as composting, better irrigation, etc.

Dynamics of the IR: Will the IR phase out in future?

If the IR is indeed phasing out, then the extra productivity from land redistribution may be short- lived.

Technological progress and the IR:Ghose (1979) argued that the IR will vanish as

technology advances, because an essential pre-condition for the IR is technological backwardness. Deolikar (1981) found that the IR hypothesis can be rejected at high levels of technology, but not at low levels.Other studies like Hazell (2011), Rao(1975) and Dyer(1991) have similar findings. Working inputs are used more intensively on SFs (Fertilisers, HYVs) but lumpy investments can be better made by LFs. In rural economies where credit is rationed and land serves as a collateral, LFs have more access to institutional credit too. Agricultural mechanization can result in higher capital- labour ratios and result in very strong economies of scale which can make SFs obsolete.This type of change has been observed in developed countries, which display DR now.

Liberalization and the IR: Comparative advantage theory says that owners of relatively abundant factors gain in international trade. So we would expect IRs to strengthen due to SFs being more labour intensive in labor abundant countries. But globalisation brings in new market changes, like emergence of supermarkets (due to opening up of FDI in retail-supermarkets took 10–20 per cent of retail food sales South America, South Africa and East Asia around 1990, but 50–60 per cent by the early 2000s), product standards and greater risk fluctuations that raise LFs competitiveness against SFs. Supermarkets tend to procure large volumes from smaller points, and the marketing cost advantages shift to LFs .Absent intermediation between SFs and supermarkets might make post harvest DR outweigh pre harvest IR.The often accompanied state withdrawal from subsidies, public infrastructure etc. harms SFs more than LFs.

An Aside:The Chicago Question

The Chicago question asks that if there is indeed an IR, atleast in a static sense; then why doesn't the land and labour market autonomously shift landholdings in favour of SFs. The IR case for land reform is made credible, only if LFs cannot, or will not, raise their net incomes either by transferring land to smaller units by sale or rental, or hiring managers to seek, screen and supervise labour over each of several units of their sub- divided farm. Land and Labour market imperfections (the expense of land transfer,legal risks like not being able to evict tenants, incomplete information,incentive problems,improper property rights,and gains from retention of LFs not related to productivity like political influence, prestige,etc) can explain this.

Conclusion

The IR generally exists in developing countries, though it is expected to get weaker with time. In India, the IR can be mainly explained by higher input intensity in smaller farms, which increase individual crop productivity and thus farm productivity.

The IR has been put forward as one of the arguments against large scale capitalist farming and in favour of redistributive land reforms.

However, some researchers find the IR-DR debate to be irrelevant and see an unwarranted obsession in land productivity as a justifying factor, driving out the necessary emphasis on equity, and on land as a basis for security and human dignity.In a country like India where majority of the population depends on the agricultural sector for livelihood and a significant proportion of the rural population falls below the poverty line, the absolute returns from SFs

must be taken into policy consideration as well. According to Chand (2011), " 62% of farmers in India, who own less than
0.80 ha of cultivable land, would be under poverty if they do not have an opportunity to earn income outside agriculture". In such a case, increasing SFs income through non-farm activities / agriculturally allied areas like animal husbandry, etc needs to be a priority area so that the twin objectives of equity and efficiency can be met.

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