Institutional response to the existence of agricultural risk: An introduction

David H. Newbery

Agricultural policy is inevitably complex, and is resolved through at least three different legal frameworks that, in turn, interact with the imperfect institutional settings which surround the agricultural sector. This section provides an overview of some of these settings and the ways in which they influence agricultural policy and outcomes. The focus is on the institutional context for agricultural policy, and the way in which this context shapes the choices of policy-makers.

Part VII

Institutional response to risk and implications for agricultural improvement
Institutional response to the existence of agricultural risk: An introduction

David G. Newbery

Agricultural policy in developing countries was once thought to be fairly simple. Eliminate or transform the inefficient traditional institutions which impeded the efficient allocation of resources in order to allow peasant agriculture to be modernized, helped perhaps by the inflow of new inputs. Sharecropping was seen as a feudal hangover which encouraged inefficiency, while the level of and variations in rates of interest in the rural credit markets were viewed as evidence of monopoly. The policy was obvious — land tenure reform to eliminate sharecropping, and the introduction of government or cooperative credit agencies to erode the moneylenders’ power. The first three chapters of this section reflect to varying degrees the enormous shift in economists’ perceptions of rural institutions, and their growing appreciation of complexity surrounding policy recommendations. In the first paper, Reid provides rich historical evidence and careful analysis to show that sharecropping can be a viable institution, and historically was becoming more prevalent in the advanced agricultural economy of the United States up until the 1930’s. He demonstrates that landlords and tenants could choose between a variety of tenurial contracts, and that some of them evidently found the share contract the most attractive. The dead hand of tradition need not be invoked to explain the existence of share tenancy, and, more important, it cannot be inferred that the institution is inefficient — if anything, quite the opposite.

Newbery and Stiglitz review the theory of share tenancy and define more precisely the conditions under which it has advantages over alternative contracts. They argue that it is potentially misleading to focus narrowly on one market or institution in analyzing the allocative efficiency of agriculture. Early studies which viewed share tenancy in isolation from the land and labor markets, and which ignored the range of possible contracts which agents might have drawn up, ignored the interdependence that becomes more complex and important when risk is recognized. Share contracts are less risky than fixed rent contracts, but so are some kinds of labor contracts, and the desirability of the one cannot be judged in isolation from the other. Instead, it seems fruitful to ask of any superficially inefficient institution whether it exists because of some market failure elsewhere in the rural economy.

The most obvious market failure is the absence of future and insurance markets, and evidently sharecropping goes some way to mitigating the harmful effects of their absence. Less obvious, but arguably more fundamental, is the costliness of information which is now recognized as crucial for understanding credit markets, and labor contracts. The credit
worthiness of the borrower is not self-evident, nor is the diligence and competence of the worker. Different contracts will attract different kinds of agents, and will provide different incentives for the fulfillment of the contract. The theory of "screening," or more widely, of incomplete information will no doubt continue to deepen our understanding of market institutions.

Lipton's paper on rural credit takes up these strands, but also reinforces a point made by Reid, that is, the heterogeneity of agents and of land is important for a satisfactory analysis of the rural sector. Model builders and theoreticians naturally simplify by assuming homogenous inputs, identical agents with identical tastes and beliefs, and are reluctant to open the Pandora's box of diversity. We need the historian and the practitioner to point to its importance and to describe its consequences before we are convinced that anything essential has been omitted. This, both Reid and Lipton do, and return the ball to the modelers' court. They provide a daunting challenge, but offer the prospects of greater insight, and the threat that policies derived from models which ignore the diversity of the rural economy may be perverse in their effects. The chapter by Hazell and Scandizzo illustrates the problems facing policy makers. They argue that if farmers make production choices on the basis of average prices, they will choose an inefficient production plan, because they will then fail to allow for the negative covariance between price and quantity. If, however, they are risk-averse, they will produce smaller quantities compared with risk neutral farmers, and as a result will produce an amount which is closer to the risk neutral efficient level. This has a disturbing empirical implication for it makes it difficult to distinguish between risk-averse behavior and imperfect expectations, and of course it does not mean that risk aversion corrects the error, since the efficient level of production must be defined relative to the preferences of the agents, and in particular must reflect attitudes to risk. Hazell and Scandizzo calculate the efficient allocation for risk-neutral producers and argue that the policy maker could intervene to distort prices in such a way that producers would choose the (risk neutral) production plan. At the conference, Newbery argued against this policy implication by showing that if farmers learned of negative association between price and aggregate supply and acted rationally, then they would choose the efficient production plan with no market intervention and any government action on prices would worsen matters. They now concede this point in their postscript, and admit that policy intervention is only warranted if there is good reason to believe that farmers make systematically mistaken forecasts. How this could ever be established given the difficulty in distinguishing between attitudes to risk and mistakes is not spelled out.

Taken together, the papers confirm Binswanger's rather pessimistic conclusion that there seem to be few, if any, risk specific policies which allow policy makers to reduce the costs of risk without harmful side effects. This in
Institutional response to risk

Itself is an important conclusion, for it should make us more generally skeptical of risk reducing panaceas, of which the latest example is the enthusiasm for buffer stocks. On the other hand, it is clear that the existence of risk, particularly in association with incomplete information, has a profound effect on the kinds of institutions which endure. The papers show how important it is to recognize this formative influence.
Chapter 16

Sharecropping and tenancy
in American history

Joseph D. Reid, Jr.*

In the year 1800, 74 per cent of American workers farmed. Now 4 per cent farm. As Table 16.1 indicates, agriculture's share of the American work force did not decline at a steady rate and did not change at the same rate across regions. In part, Table 16.1 reflects the uneven incidence of changed conditions (input supplies, output demands, and available techniques) in American agriculture. In part, Table 16.1 reflects the uneven response by farmers to changed conditions. In all, Table 16.1 reflects that from earliest times, American farmers faced change. They responded with hard work, migration, education, and risk taking. To do so, they sought many and got some institutions to assist them. A variety of tenures was one of the most enduring.

In terms of raw numbers, rent and share tenancy bulk large in the agricultural history of the United States. In 1880, the first year in which the census reported the tenure status of farm operators, 74 per cent of the farms were cultivated by owners who were often encumbered by mortgages, 8 per cent by renters who paid a landowner either a fixed amount of cash or of crops, and 18 per cent by sharecroppers who paid the landowner a share of their crops. As Table 16.2 shows, the distribution of farmers among tenures in 1880 varied across regions. Tenants were most prevalent in the South, but

*Critical comments on an earlier version of this paper by S. Engerman, C. Goldin, D. McCloskey, E. Meeker, H. Neuberger, N. Reid, G. Wright, and the participants in the ADC Conference on Uncertainty and Agricultural Development are much appreciated, as is the research assistance of J. Bender and B. Lewis. NSF Grant SOC75-19084 provided financial support.
Table 16.1

Per cent of the work force in agriculture, selected years and regions

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<thead>
<tr>
<th>Region</th>
<th>1800</th>
<th>1850</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1960</th>
<th>1970</th>
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<td>U.S.1</td>
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<td>54.8</td>
<td>37.5</td>
<td>30.9</td>
<td>27.0</td>
<td>21.2</td>
<td>17.4</td>
<td>11.8</td>
<td>6.1</td>
<td>3.1</td>
</tr>
<tr>
<td>South2</td>
<td>82</td>
<td>84</td>
<td>57.9</td>
<td>57.3</td>
<td>46.8</td>
<td>39.0</td>
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<td>21.7</td>
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<td>14.2</td>
<td>12.5</td>
<td>8.9</td>
<td>5.1</td>
<td>2.9</td>
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<td>-</td>
<td>36.6</td>
<td>31.5</td>
<td>25.4</td>
<td>19.2</td>
<td>19.2</td>
<td>13.5</td>
<td>8.0</td>
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</tr>
<tr>
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<td>-</td>
<td>-</td>
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<td>10.0</td>
<td>6.9</td>
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<td>4.4</td>
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1U.S. totals include Alaska and Hawaii for 1960 and later years only.
2Subregions (states) included: South Atlantic (Delaware, D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia); East South Central (Alabama, Kentucky, Mississippi, Tennessee); West South Central (Arkansas, Louisiana, Oklahoma, Texas).
3Subregions (states) included: East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin); West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota).
4Subregions (states) included: New Jersey, New York, Pennsylvania.
were absent nowhere; likewise, sharecroppers were most prevalent in the South, but sharecroppers were more prevalent than renters in every region — and were three times as prevalent as renters in the North Central region. Table 16.2 shows that the prevalence of fixed rent and share tenants increased irregularly until the 1930's and diminished thereafter both in terms of proportion of all farmers and proportion of acres farmed. Tenancy was about 1.8 times as common in the South as outside the South. Table 16.2 shows that the prevalence of tenancy over time followed the same inverted U pattern in both regions, rising to about 1.5 times its 1880 prevalence in the thirties, then declining. Table 16.3 shows that tenant farms were about three-fifths the size of owner-operated farms throughout this period. Table 16.4 shows that about one-half of the farm workers did not operate farms under any tenure; one-quarter worked for no wage on their families' farms and another quarter worked for wages on others' farms.

Tenancy statistics for the years before 1880 are sparse and scattered. However, it is clear that not even in early colonial times did every farmer own his land. Menard (1973) noted that former indentured servants frequently became tenants in seventeenth century Maryland. Innes (1976) found that a majority of eighteenth century farmers in Springfield, Massachusetts were rent or share tenants at some time in their lives. As early as 1821, share and fixed rent leases were used in the South (Reid, 1976a). Tenants were common in antebellum New York and New Jersey (Bidwell and Falconer, 1925, p. 449; Ellis, 1944). Frontier landlords of Ohio, Indiana, Illinois, and points farther west frequently sought share tenants and renters (Gates, 1973). In sum, from the earliest times to the present, tenant farmers have been present in American history. In particular, neither renters nor sharecroppers were southern or post-civil war phenomena. But do the facts and forms of American tenancy have substantive implications for American history or for contemporary agriculture elsewhere?

Many have asserted that tenancy does indeed have historical consequences. As is well known, until very recently economists believed that tenants would farm inefficiently; renters would slight permanent improvements to their lands, and share tenants would stint their labor as well (Adams and Rask, 1968; Bardhan and Srinivasan, 1971; Bhagwati, 1966; Cheung, 1969, Ch. 3; Marshall, 1964, pp. 535-36; Smith, 1937, pp. 367-68). The rationale for these presumed inefficiencies is that tenants have less incentive than owner cultivators to farm efficiently. Short-term renters cannot be sure to receive the full payback from an improvement, and share tenants get back but a fraction of the value of their effort and improvements.

1Renters who paid a fixed amount of crop (standing renters) were apparently counted as share tenants in the censuses of 1880 and 1890 (1920 Census of Agriculture, p. 121). However, the predominance of share over fixed rent tenants persisted through 1920 (1920 Census of Agriculture, p. 124, Table 3).
Table 16.2
Percentage distribution of farm operators, by tenures, selected regions, 1880-1964

<table>
<thead>
<tr>
<th>Region and Race</th>
<th>Tenure</th>
<th>1880</th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
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<th>1940</th>
<th>1950</th>
<th>1959</th>
<th>1964</th>
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<td>42.4</td>
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<td>9.1</td>
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<td>24.8</td>
<td>28.0</td>
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<td>50.4</td>
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NA — Not available


1 Includes full owners, part owners, and managers.
2 Other and unspecified included with cash tenants for 1900.
3 Census data for individual tenant categories do not add to total tenants. Variances for U.S. (approximately 2% of total tenants) and regions were included in "Other and unspecified" categories.
Table 16.3

Average farm size, selected regions, 1880-1964, by color and tenure of operator

<table>
<thead>
<tr>
<th>Region and Race</th>
<th>Tenure</th>
<th>1880</th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1959</th>
<th>1964</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States-All</td>
<td>Owners (full and part)</td>
<td>149.4</td>
<td>145.7</td>
<td>152.2</td>
<td>151.6</td>
<td>162.2</td>
<td>173.3</td>
<td>184.5</td>
<td>214.9</td>
<td>288.1</td>
<td>327.6</td>
</tr>
<tr>
<td></td>
<td>Tenants:</td>
<td>87.9</td>
<td>100.7</td>
<td>96.3</td>
<td>96.2</td>
<td>107.9</td>
<td>115.0</td>
<td>132.1</td>
<td>146.6</td>
<td>221.8</td>
<td>268.4</td>
</tr>
<tr>
<td></td>
<td>Cash</td>
<td>93.4</td>
<td>102.9</td>
<td>102.9</td>
<td>95.3</td>
<td>122.2</td>
<td>145.9</td>
<td>196.1</td>
<td>317.0</td>
<td>372.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>85.4</td>
<td>99.5</td>
<td>92.4</td>
<td>93.2</td>
<td>102.4</td>
<td>108.1</td>
<td>129.3</td>
<td>243.7</td>
<td>300.1</td>
<td>255.6</td>
</tr>
<tr>
<td></td>
<td>Livestock share</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>142.3</td>
<td>133.6</td>
<td>111.0</td>
<td>129.5</td>
<td>166.4</td>
<td>188.1</td>
</tr>
<tr>
<td></td>
<td>Other and unspecified</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>South-All</td>
<td>Owners (full and part)</td>
<td>201.7</td>
<td>180.9</td>
<td>162.8</td>
<td>149.3</td>
<td>138.1</td>
<td>134.3</td>
<td>141.7</td>
<td>162.4</td>
<td>221.4</td>
<td>247.4</td>
</tr>
<tr>
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<td>Tenants:</td>
<td>68.4</td>
<td>73.9</td>
<td>71.2</td>
<td>64.5</td>
<td>67.3</td>
<td>70.0</td>
<td>84.9</td>
<td>89.7</td>
<td>138.1</td>
<td>177.7</td>
</tr>
<tr>
<td></td>
<td>Cash</td>
<td>80.5</td>
<td>82.1</td>
<td>85.6</td>
<td>76.0</td>
<td>88.2</td>
<td>114.1</td>
<td>130.1</td>
<td>177.4</td>
<td>310.9</td>
<td>351.8</td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>62.5</td>
<td>69.5</td>
<td>62.6</td>
<td>58.8</td>
<td>61.2</td>
<td>63.3</td>
<td>73.6</td>
<td>196.3</td>
<td>266.5</td>
<td>135.2</td>
</tr>
<tr>
<td></td>
<td>Livestock share</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>91.6</td>
<td>88.0</td>
<td>101.8</td>
<td>131.8</td>
<td>147.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other and unspecified</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>South-White</td>
<td>Owners (full and part)</td>
<td>NA</td>
<td>NA</td>
<td>177.2</td>
<td>162.1</td>
<td>149.7</td>
<td>144.8</td>
<td>152.0</td>
<td>174.9</td>
<td>238.4</td>
<td>265.2</td>
</tr>
<tr>
<td></td>
<td>Tenants:</td>
<td>92.5</td>
<td>83.8</td>
<td>90.4</td>
<td>91.0</td>
<td>109.0</td>
<td>124.9</td>
<td>200.3</td>
<td>245.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cash</td>
<td>140.3</td>
<td>114.5</td>
<td>138.8</td>
<td>164.6</td>
<td>157.5</td>
<td>238.7</td>
<td>422.4</td>
<td>452.8</td>
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</tr>
<tr>
<td></td>
<td>Share</td>
<td>74.3</td>
<td>72.7</td>
<td>78.4</td>
<td>80.2</td>
<td>80.6</td>
<td>86.0</td>
<td>198.4</td>
<td>192.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Livestock share</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>104.0</td>
<td>102.3</td>
<td>119.2</td>
<td>169.6</td>
<td>189.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other and unspecified</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>South-Non-white</td>
<td>Owners (full and part)</td>
<td>NA</td>
<td>NA</td>
<td>71.6</td>
<td>71.8</td>
<td>64.7</td>
<td>63.1</td>
<td>60.4</td>
<td>62.7</td>
<td>68.2</td>
<td>70.7</td>
</tr>
<tr>
<td></td>
<td>Tenants:</td>
<td>44.9</td>
<td>39.6</td>
<td>38.2</td>
<td>37.3</td>
<td>40.0</td>
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<td>35.3</td>
<td>36.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cash</td>
<td>48.0</td>
<td>45.0</td>
<td>46.8</td>
<td>41.8</td>
<td>49.7</td>
<td>53.0</td>
<td>52.8</td>
<td>53.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>42.0</td>
<td>35.6</td>
<td>35.1</td>
<td>36.0</td>
<td>34.2</td>
<td>35.3</td>
<td>32.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Livestock share</td>
<td>NA</td>
<td>NA</td>
<td>—</td>
<td>—</td>
<td>45.4</td>
<td>60.9</td>
<td>53.8</td>
<td>39.1</td>
<td>40.3</td>
<td></td>
</tr>
</tbody>
</table>
### North Central - All Owners (full and part)\(^1\)

<table>
<thead>
<tr>
<th>Tenants</th>
<th>126.8</th>
<th>135.3</th>
<th>146.7</th>
<th>156.3</th>
<th>165.8</th>
<th>172.0</th>
<th>175.9</th>
<th>204.7</th>
<th>257.2</th>
<th>289.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>102.9</td>
<td>127.2</td>
<td>129.0</td>
<td>152.0</td>
<td>177.6</td>
<td>192.5</td>
<td>196.2</td>
<td>222.8</td>
<td>272.5</td>
<td>304.2</td>
</tr>
<tr>
<td>Share</td>
<td>101.4</td>
<td>123.8</td>
<td>122.7</td>
<td>138.1</td>
<td>154.7</td>
<td>151.4</td>
<td>132.5</td>
<td>165.7</td>
<td>215.6</td>
<td>252.4</td>
</tr>
<tr>
<td>Livestock share</td>
<td>103.4</td>
<td>128.8</td>
<td>132.3</td>
<td>159.3</td>
<td>187.8</td>
<td>207.0</td>
<td>225.2</td>
<td>246.7</td>
<td>292.9</td>
<td>326.5</td>
</tr>
<tr>
<td>Other and unspecified</td>
<td>NA</td>
<td>NA</td>
<td>3</td>
<td>3</td>
<td>154.8</td>
<td>140.8</td>
<td>153.0</td>
<td>179.9</td>
<td>205.3</td>
<td></td>
</tr>
</tbody>
</table>

### Middle Atlantic - All Owners (full and part)\(^1\)

<table>
<thead>
<tr>
<th>Tenants</th>
<th>92.3</th>
<th>87.7</th>
<th>86.1</th>
<th>85.3</th>
<th>88.7</th>
<th>92.8</th>
<th>92.8</th>
<th>104.4</th>
<th>133.1</th>
<th>149.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>107.0</td>
<td>106.1</td>
<td>104.5</td>
<td>107.4</td>
<td>109.2</td>
<td>114.4</td>
<td>106.4</td>
<td>119.5</td>
<td>134.8</td>
<td>145.9</td>
</tr>
<tr>
<td>Share</td>
<td>89.3</td>
<td>91.2</td>
<td>85.2</td>
<td>87.2</td>
<td>89.3</td>
<td>96.1</td>
<td>87.1</td>
<td>111.1</td>
<td>137.7</td>
<td>148.0</td>
</tr>
<tr>
<td>Livestock share</td>
<td>119.4</td>
<td>116.0</td>
<td>119.3</td>
<td>124.0</td>
<td>122.5</td>
<td>126.5</td>
<td>135.1</td>
<td>122.9</td>
<td>140.2</td>
<td>157.2</td>
</tr>
<tr>
<td>Other and unspecified</td>
<td>NA</td>
<td>NA</td>
<td>3</td>
<td>3</td>
<td>94.8</td>
<td>97.3</td>
<td>102.9</td>
<td>111.8</td>
<td>131.2</td>
<td></td>
</tr>
</tbody>
</table>

**Sources:** Computed or obtained directly from the following:


NA — Not available

\(^1\) Excludes managed farms except for 1880 and 1890 when owned and managed farms were not separately enumerated.

\(^2\) Estimated using data by size of farm; data on total acres by tenure were not available.

\(^3\) Included with cash tenants.
<table>
<thead>
<tr>
<th>Year</th>
<th>1800</th>
<th>1810</th>
<th>1820</th>
<th>1830</th>
<th>1840</th>
<th>1850</th>
<th>1860</th>
<th>1870</th>
<th>1880</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm operators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owners</td>
<td>600 (43%)</td>
<td>830 (43%)</td>
<td>1040 (42%)</td>
<td>1235 (42%)</td>
<td>1440 (40%)</td>
<td>1800 (40%)</td>
<td>2540 (43%)</td>
<td>3130 (46%)</td>
<td>4300 (48%)</td>
</tr>
<tr>
<td>Tenants</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>2980 (33%)</td>
</tr>
<tr>
<td><strong>Farm workers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpaid family</td>
<td>800 (57%)</td>
<td>1120 (57%)</td>
<td>1430 (58%)</td>
<td>1730 (58%)</td>
<td>2130 (60%)</td>
<td>2720 (60%)</td>
<td>3340 (57%)</td>
<td>3660 (54%)</td>
<td>4620 (52%)</td>
</tr>
<tr>
<td>Hired</td>
<td>310 (22%)</td>
<td>415 (21%)</td>
<td>515 (21%)</td>
<td>610 (20%)</td>
<td>720 (20%)</td>
<td>850 (19%)</td>
<td>1120 (19%)</td>
<td>3660 (54%)</td>
<td>4620 (52%)</td>
</tr>
<tr>
<td>Slaves</td>
<td>490 (35%)</td>
<td>705 (36%)</td>
<td>915 (37%)</td>
<td>1120 (38%)</td>
<td>1410 (40%)</td>
<td>1870 (41%)</td>
<td>2220 (38%)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1400 (100%)</td>
<td>1950 (100%)</td>
<td>2470 (100%)</td>
<td>2965 (100%)</td>
<td>3570 (100%)</td>
<td>4520 (100%)</td>
<td>5880 (100%)</td>
<td>6790 (100%)</td>
<td>8920 (100%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1960</th>
<th>1970</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm operators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owners</td>
<td>4890 (49%)</td>
<td>5830 (50%)</td>
<td>6362 (47%)</td>
<td>6448 (48%)</td>
<td>6289 (50%)</td>
<td>6097 (56%)</td>
<td>5382 (54%)</td>
<td>3962 (56%)</td>
<td>2954 (65%)</td>
</tr>
<tr>
<td>Tenants</td>
<td>3290 (33%)</td>
<td>3710 (32%)</td>
<td>4007 (30%)</td>
<td>3993 (30%)</td>
<td>3624 (29%)</td>
<td>3726 (34%)</td>
<td>3938 (40%)</td>
<td>3178 (45%)</td>
<td>2573 (57%)</td>
</tr>
<tr>
<td><strong>Farm workers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpaid family</td>
<td>1600 (16%)</td>
<td>2120 (18%)</td>
<td>2355 (17%)</td>
<td>2455 (18%)</td>
<td>2665 (21%)</td>
<td>2261 (22%)</td>
<td>1444 (14%)</td>
<td>784 (11%)</td>
<td>381 (8%)</td>
</tr>
<tr>
<td>Hired</td>
<td>5070 (51%)</td>
<td>5850 (50%)</td>
<td>7193 (53%)</td>
<td>6984 (52%)</td>
<td>6208 (50%)</td>
<td>4882 (44%)</td>
<td>4544 (46%)</td>
<td>3095 (44%)</td>
<td>1569 (35%)</td>
</tr>
<tr>
<td>Slaves</td>
<td>5070 (51%)</td>
<td>3470 (30%)</td>
<td>3817 (28%)</td>
<td>3593 (27%)</td>
<td>3018 (24%)</td>
<td>2203 (20%)</td>
<td>2215 (17%)</td>
<td>1710 (17%)</td>
<td>389 (9%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9960 (100%)</td>
<td>11680 (100%)</td>
<td>13555 (100%)</td>
<td>13432 (100%)</td>
<td>12497 (100%)</td>
<td>10979 (100%)</td>
<td>9926 (100%)</td>
<td>7057 (100%)</td>
<td>4523 (100%)</td>
</tr>
</tbody>
</table>

Table 16.5

Value of output per cultivated acre on a sample of small farms in the South, 1880

<table>
<thead>
<tr>
<th>Race</th>
<th>Tenure</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Own</td>
<td>Rent</td>
<td>Share</td>
</tr>
<tr>
<td>White</td>
<td>$22.64</td>
<td>$17.90</td>
<td>$17.22</td>
</tr>
<tr>
<td>Black</td>
<td>$23.63</td>
<td>$22.00</td>
<td>$20.07</td>
</tr>
</tbody>
</table>

Source: Full-time laborers per acre in crops, Table 3, p. 143, multiplied by value of output per full-time laborer, Table 4, p. 144 of Ransom and Sutch, 1973.

Figure 16.1. The traditional model of tenancy
Both arguments are developed easily in the simple triangle of Figure 16.1. For the renter, the present marginal productive value of each amount of improvement is measured along the vertical axis and the amount of improvement per acre along the horizontal axis. The relation of marginal productive value to amount of improvement is graphed as the line $DEGF$ in Figure 16.1. As the renter’s term shortens or becomes less secure, his anticipated share in the value of his improvements — graphed as the line $ABIF$ in Figure 16.1 — declines ($ABIF$ pivots on $F$ toward the origin). In consequence, although the marginal cost of improvements — graphed as the line $WW^*$ in Figure 16.1 — indicates that $n_i$ of improvements might profitably be made, the renter actually makes only the lesser amount of improvements $n_i$. For the sharecropper, the value marginal product of his effort per acre (vertical axis) is graphed as a function of his effort (horizontal axis) in the line $DEGF$ of Figure 16.1. His share of his marginal output is but a fraction, and is represented by $ABIF$, which pivots on $F$ toward the origin as his share declines. Hence, although the marginal cost of his effort $WW^*$ indicates that $n_i$ is the optimal amount of effort, the sharecropper supplies the lesser amount $n_i$.

The irrefutable logic and economists’ pleasures in triangles made these deduced inefficiencies of tenancy almost sacrosanct, and they still buttress contemporary land-to-the-tiller reform programs in developing countries (Ruttan, 1964). These inefficiencies found ready support among observers and analysts of American agriculture. Banks (1905) ascribed the impoverished state of agriculture in postbellum Georgia in part to the attenuated incentives for share tenants to farm efficiently. He excluded renters from his indictment, as did many respondents to the survey of labor conditions in the postbellum South by Hilgard (1884). Gates (1973) ascribed the lower value of farm dwellings and greater extent of soil depletion in the prairie countries of 1930 Indiana to the greater proportion of tenants in the prairie counties. Gates (1973) elsewhere quoted an editorial column reprinted in the Pontiac, Illinois Free Trader and Observer in 1883 that:

Rented farms can always be identified by the dilapidated state of the buildings, the tumble-down fences, the mammoth crop of weeds, the unthrifty general appearance... The rented farm is free to be plucked in almost every possible manner... The whole object too, is to secure the utmost drain on the soil... (1973, p. 281).

This list of adverse comments on American tenancy could be extended (Reid, 1977). Yet economists have not been able to find convincing empirical support for these propositions. In the first place, the classical arguments against tenancy imply that the landowner receives less than the foregone marginal product of his land. But few American landlords seem to have been

2In Figure 16.1, the stinting of investment by tenants reduces value per acre by the trapezoid $CEGH$: the additional stinting of effort by share tenants reduces output per acre by that same area.
or to have needed to be content with below-market earnings. Southern landlords, ante-bellum and post-bellum, entered into contracts with renters and share tenants alike which stipulated: (1) how long the land would be tenanted; (2) which crops could be grown on which fields; (3) acceptable cultivation practices (horizontal drills, for example); (4) landlord’s and tenant’s maintenance and improvement obligations (clearing, ditching, fencing, and the like); and (5) penalties for noncompliance as well as (6) the form (fixed or share) and amount (in cash or kind) of the rent (Reid, 1973, 1976a; Taylor, 1943). Although less is known, landlords in colonial Massachusetts (Innes, 1976) and in the post-1865 Midwest (Winters, 1974) apparently took similar steps to guard their current and future incomes. Furthermore, landlords themselves or their agents monitored these contracts; they reprimanded or dismissed unsatisfactory tenants and rewarded exceptional tenants with larger farms or more lenient terms (Gates, 1973; Reid, 1973, 1976a).

Much evidence suggests the landlords’ effort to get their opportunity rents paid off. The ante-bellum planter and post-bellum Southern farmer and landlord, David Harris, surveyed his rent and share tenants and concluded, “I have rented my land for about as much as I usually made with my negroes and mules” (Reid, 1973, p. 115). Warren and Livermore (1911, p. 398) estimated that owner operators near Ithaca, New York, made 6.7 per cent on their farm investment, but that landlords earned 8.3 per cent. Gray and Lloyd (1920, pp. 28-32) calculated that Iowa landlords got about as much return on capital as owner operators did. Furthermore, many farm management and other studies discredit the classical contention that share rents fall short of fixed rents. Winters (1974, pp. 137-8) found that gross share rents exceeded average cash rents of $2.72 per cropped acre by 37 per cent (third shares) to 128 per cent (half shares) on farms in late nineteenth century Iowa. Such an excess persisted in Iowa through 1945, at least (Berry, 1962, p. 802; Gray and Lloyd, 1920, p. 28; Holmes, 1923, p. 358; Johnson, 1950, p. 118). A similar gap between share and cash rents prevailed outside of Iowa as well (Forster, 1922, p. 62; Haskell, 1918, pp. 16-7; Spillman, Dixon, and Billings, 1916, p. 72; Warren and Livermore, 1911, p. 541).

Yet not all studies imply that tenants farm as efficiently as owners or that share tenants work as hard as fixed renters. Sanders (1922, p. 25) concluded that Texas black-land owner-operator realized about twice the rate of return

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3For more recent data, see Wilcox (1918). Agricultural experiment stations in various states periodically surveyed local farm leases. A few such are Hibbard and Black (1920), Holmes (1923), McCord (1929), Taylor (1910), and Wrigley (1939).

4It seems clear that American landlords differed little from the Chinese landlords described by Cheung (1969, pp. 75-80).

5Because none of the share landlords' differential expenses are deducted from these share returns, these differences between returns from share and fixed rent tenants much exceed the more meaningful net differences.
on farm capital than landlords did. Rough calculations based upon data from a
cross section study of tenants in 1913 in the Yazoo-Mississippi Delta imply
that sharecroppers, who supplied their labor and one half of any fertilizer in
return for half the crops, yielded landlords $17.83 per cultivated acre or 19 per
cent on the landlords' land and other capital. Share renters (who supplied work
stock, tools, and seed, as well as labor, in return for between two-thirds and
three-fourths of the crop) yielded landlords between $10.83 and $14.03 per
acre or between 13.3 per cent and 17.3 per cent on landlords' capital (the exact
rates depend on the actual shares). Fixed renters returned $17.50 per acre or
21.5 per cent to landlords (Boeger and Goldenweiser 1916, pp. 7-9). Also in
accord with the classical predictions, the data in Table 16.5 imply that small
(50 or less acres in crops) owner cultivators in the postbellum South produced
more value per acre in crops than did renters, and that renters produced more
than did share tenants. However, Boeger and Goldenweiser (1916) reported
that share tenants raised 13 per cent more cotton per acre than did renters, and
equal amounts of corn. So alternative explanations of the data in Table 16.5
may be valid. One likely alternative is that white owners and blacks
disproportionately tilled the best cotton (highest value crop) lands, while white
tenants disproportionately farmed less valuable lands (DeCanio, 1974, Ch. 6;
Haskell, 1918, p. 16; Higgs, 1974; Reid, 1973). Another is that more
impoverished blacks gambled more on high value, high risk cotton (Wright
and Kunreuther, 1975). If so, the values of output per acre recorded in Table
16.5 might well have resulted. More in accord with the classical explanation,
however, is Ransom and Sutch's (1973) implicit statement that racial
discrimination made black tenants easier for landlords to control. Also
consistent with the classical predictions is the study by Heady (1955). Heady
(1955) fitted production functions to data from midtwentieth century Iowa
farms and inferred that share tenants did apply less inputs per acre than did
renters or owners. However, Heady (1955) also inferred that share rents
exceeded cash rents by 46 per cent to 83 per cent, and that, although both
enjoyed marked economies of scale, the production function of share tenants
structurally differed from that of renters. Higher share rents are difficult to
reconcile with increased stinting by share tenants and Miller (1959) fitted like
production functions to like farms and found neither evidence of economies of
scale nor of insufficient inputs by tenants. It is likely, therefore, that Heady's
(1955) novel conclusions reflect more the difficulties of estimating production
functions from cross section data than the classical inefficiencies of tenant
agriculture.

However, the data are ambiguous on the efficiency of tenants. In the end,
it is the persistence of rent and share tenancy in American agriculture and the

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6 It should be noted that 1913 was an exceptional year for cotton: bales per acre were .59
against an average of .47 over the years 1909-1913. Furthermore, the studied tenants were
exceptional: they raised .66 bales per acre in 1913 (Boeger and Goldenweiser, 1916, p. 4).
inability to explain why landlords would persistently mismanage their land which makes the most compelling argument for the productivity of tenant farmers. Considered as a static, continuing phenomenon, then, the important question posed by the classical analysis of tenancy is not "how inefficient are renters and sharecroppers" but "how are their proclivities to stint overcome."

Several means to discourage stinting have been suggested. Above, I noted that American landlords and tenants typically entered into agreements which carefully specified the nature and amount of tenant efforts, and that landlords monitored their tenants' performances. Johnson (1950, pp.118-9) suggested other means for landlords to check tenants, including that: (a) landlords vary their supply rate of complementary inputs (fertilizer, for example), (b) landlords specify crops which have fixed labor input requirements, and (c) landlords reduce their tenants' land supplies that income effects outweigh substitution effects in determining the tenants' supplies of effort. The use of each means finds at least some indirect support in the facts. For example, southern landlords often furnished all fertilizers to share tenants (those tenants with an incentive to stint their cropping efforts, as well as their maintenance and improvement efforts), and specified and purchased the amounts used even when the share tenant paid a proportion of the cost (Reid, 1973). Perhaps the promise of fertilizer helped to keep the share tenants' preparation industrious, and the shared product of fertilizer reduced their incentive to shirk thereafter.\footnote{Such efficacious use of complementary inputs is certainly consistent with the reported evolution of country storeowners into tenant landlords in the postbellum South — the storeowners' control over tenants' weekly allotments of goods potentially checked shirking. However, I believe that that evolution stemmed from causes other than efficiencies of tenant control. Storeowners seem to have gotten control of their lands long before they exercised management over them, and the initial landowners seem not to have tried to control their tenants' trade (Reid, 1973).}

Perhaps, fixed input requirements explain in part why the southern landlords studied by Boeger and Goldenweiser (1916, p. 8) furnished half-and-half sharecroppers better than average quality mules and, at the same time, kept continuing control over those sharecroppers' use of machinery and implements. But, at best, these are speculative supports for landlords' use of such means.\footnote{\label{5}Below, I consider management as the most important complementary input.}

Typically, share landlords more closely specified their tenants' crops and activities than fixed-rent landlords did, and share tenants cultivated a greater proportion of labor intensive crops on a higher proportion of improved acreage. For example, southern share tenants cultivated proportionately more cotton.\footnote{Willard (1918, p. 50) estimated that cotton required 5.7 man-days and 3.2 mule days per acre on farms in Ellis County, Texas, that corn required 2.0 man-days and 3.3 mule days per acre, and wheat 7.2 man-days and 1.27 mule-days per acre. Smith (1918, p. 9) estimated that cotton required twice as many man-days and a fourth more mule-days than corn in Anderson County, South Carolina. But if the typical share crops required more effort, they required it on
a less rigid schedule. Southern landlords mentioned the relative flexibility of cotton's labor requirements as one reason for favoring cotton for share tenants. Other reasons were that cotton's inedibility and bulk made its private appropriation by tenants less likely. Midwestern share tenants disproportionately raised corn, higher but likewise more flexible in its labor requirement than the small grains. More to the point, on like farms, the crop proportions did not differ markedly from those of renters and owner operators (Holmes, 1923, pp. 352-3; Spillman, Dixon, and Billings, 1916, p. 70; Warren and Livermore, 1911, pp. 449-50). Thus, it seems that the regulation of share tenants involved more than choice of a self-regulating crop.

On the surface, the data offer more support for landlords' use of small plots to stimulate tenants' efforts. In general, tenant farms were smaller than owner-operated farms, and sharecropped farms were smaller than rented farms (Tables 16.3 and 16.6). Differences between owned, rented and sharecropped farms are much reduced and sometimes reversed, however, when the data are disaggregated by race and region and more relevant improved acreage is considered: the proportion of acreage improved was highest for sharecropped farms, somewhat less for rented farms, and lowest for owner operated farms — a ranking which, among other things, reflects the past custom of tenants to get fuel (a product of unimproved acres) from landlords, as well as tenants' greater concentration upon crops, rather than upon livestock. More damning of this hypothesis is its lack of theoretical rationale: if landlords have market power sufficient to force share tenants onto a smaller than competitive size plot, why would they use that power to get share tenants to labor as diligently as renters, when they could more profitably use that power to extort higher than competitive rents from renters?

In the end, the potential means by which landlords directly control tenants are varied and the actual means are even more ambiguous than their efficacy. If there is any other conclusion to draw, perhaps it is that with all of these means and their seeming success, maybe tenancy — and sharecropping, in particular — should be seen less as a problem in landlord control and more as an instrument for agricultural productivity.

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10 There is some reason to suspect that the relative predominance of cotton with southern share tenants has been stressed too much. Tenants' greater concentration on cotton to some extent stemmed from the postbellum subdivision of plantations into tenant "farms" isolated from pastures and woodlands and therefore from food for stock (Brannen, 1924; Prunty, 1955). At least one survey found that on like farms, the cropping pattern of southern share tenants differed little from that of owner-operators (Willard, 1918, p. 15).

11 Farms in the north central (wheat) region are an exception. See Schultz (1940) for other exceptions and a perceptive analysis of the reasons involved.

12 These statements seem to be true of other lands as well. See Cheung (1969) and Rao (1971).
Not only were tenant farms smaller than owner-operated farms, they also were operated with much fewer implements and machinery, buildings, and livestock per improved acre. This summary description remains less generally valid when the data are disaggregated by race and region (Table 16.6). But, on the whole, American tenant farms looked poorer than did owner operated farms. If the classical conclusions are wrong and tenants farm as efficiently as owners farm, then what explains the seeming poverty of tenant agriculture?

One answer — long favored by historians (Spillman, 1919) — is that imperfections in the capital market forced would-be owner-operator to accumulate needed physical and human capital by a climb up the rungs of an agricultural ladder: from wage labor to share tenant to renter to owner. Upon which rung a future owner commenced his climb and the size of his steps depended upon circumstances: a first son might step directly from family farm worker to inheritor-owner, an impoverished immigrant might step slowly one rung at a time. In climbing the ladder, the hired worker used another’s capital to earn a riskless wage and to learn how to farm. Having some wealth in accumulated knowledge and tools, the share tenant assumed some responsibility for direction of his efforts and some risk from his now personally more estimable yield — and thereby reaped some managerial and risk-bearing premiums. Having more human and physical capital, the renter appropriated all managerial and risk premiums, except those associated with land’s future value. Having gained more wealth, the operator assumed all of the risks and responsibilities of ownership as well.

If the transfer from landlords to laborers of human and physical capital was perfect on each rung of the ladder, returns to risk bearing and managerial ability would raise owners’ incomes above tenants’, and tenants’ incomes above laborers’, but would not produce differences in farm practices among tenures (as proved below). But neither human nor physical capital is transferred costlessly. Learning is difficult and frequently is best acquired from experience. Institutional constraints and the inability of lenders to know borrowers as well as borrowers know themselves lead lenders to conservatively

13That frontier tenant farms were often let for the completion of specified improvements (breaking, draining, fencing, and the like) plus a portion of the crops (Gates, 1973; Reid, 1976a; Winters, 1974) suggests that more highly improved tenant farms come with settled agriculture, and that the ratio of improved to total acres might be inversely related to tenancy in frontier areas. Because the census did not report data on tenures until 1880 — just ten years before the frontier officially disappeared — any such inverse association is largely missing in census data. For the engrossing details of frontier agriculture, see A. Bogue (1963) and M. Bogue (1959).

14It is plausible that the poverty of tenant — and, especially, share tenant — farms and farmers prompted the classical theories of tenant inefficiency, and explain the lingering acceptance of the classical conclusions yet. Such visible poverty prompted Young’s (1929, passim) condemnation of sharecropping and Smith’s (1937, pp. 366-69) of all insecure tenancy, and influenced greatly Marshall’s (1964, pp. 534-36) analysis.
Table 16.6

Acres $A$, improved acres $I$, % of acres improved; values of implements and machinery per acre $M$ and per improved acre $m$, buildings per acre $B$ and per improved acre $b$, livestock per acre $L$ and per improved $l$, land + acres $V$ and land + improved acres $v$, for selected races and regions by tenures, 1910 and 1940. Superscript $a$ representing acres, $b$ representing cents.

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<th>Tenure</th>
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<th>$I^a$</th>
<th>$M^b$</th>
<th>$m^b$</th>
<th>$B^b$</th>
<th>$b^b$</th>
<th>$L^b$</th>
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<td>58</td>
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<td>761</td>
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<td>48</td>
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Sources: Computed or obtained directly from Thirteenth Census of the United States, 1910, Vol. V, Tables 16 (p. 182), 18 (p. 184), 23 (p. 191), and 24 (p. 198); and from Sixteenth Census of the United States, 1940, Vol. III, chap. I, Tables 2 (pp. 146-148), 3 (pp. 154-156), 22 (pp. 164-166), 23 (pp. 193-195); Chap. VII, Table 10 (pp. 584-585).

1 Excludes managed farms.
2 Improved acres were estimated by summing the following 1940 categories of land: crop land harvested, crop failure, idle or fallow crop land, plowable pasture. The resulting estimate of 530.1 million acres compares with an estimate of 537.1 million acres, based on more detailed unpublished Bureau of the Census data, made by Tose (1957, pp. 39-31).
3 Horses and mules, all races, all tenures.
4 All other livestock, all races, all tenures.
restrict the amounts and uses of borrowed capital (Schultz, 1940). For example, the lender of cash requires that the most certain or most marketable crops be grown, and the lender of plows and like tools prescribes their use in rocky fields. Thus, the farmer with relatively more brawn than brain and wealth and the farmer with more brain and wealth than brawn, to some extent, choose their activities to suit their immediate circumstances, rather than lend and borrow to equalize their immediate circumstances. Hence, desire for diversification and lessened strength with age are two of the reasons that owner-operators have proportionally more unimproved land than do tenants. With positive costs of employment away from home and limited capabilities, young children likely influence the substitution of child labor for nonland capital, as well as encourage the relative concentration on more labor intensive crops by younger (and therefore more likely tenant) families.\(^{15}\) By this reasoning, as farmers climb the agricultural ladder, they substitute nonland capital for labor in production of every crop and undertake the production of more complex crops.\(^{16}\) Thus, in American history, life-cycle effects are part of the reason why tenant farms were smaller, more improved, and more labor intensive (Salter, 1943). In sum, that tenancy eased the flows of human and physical capital between borrowers and lenders is an important reason for its use. That it did not perfect those flows explains why share rented, fixed rented, and owner-operated farms yet differed.

In recent years, faith in the existence or operation of an agricultural ladder has waned — principally because tenancy persisted, even grew, through good times and bad (Cox, 1944), as Table 16.2 shows. But this is a weak reason to disavow an agricultural ladder. Resulting from changes in the demands for and the supplies of different tenures, the increase in tenancy between 1880 and 1935 by itself reveals nothing about the existence or operation of that ladder. Suggestive of a functioning ladder are the 1920 cross-section evidences that the vast majority of new tenants previously were hired hands and that a majority of new owners previously were hired hands or tenants (Table 16.7). Similarly suggestive of a working ladder are the data that share tenants were younger than renters, who in turn were younger than owners (Tables 16.8 and 16.9). Finally, Table 16.10 indicates that there was net entry into farm operator status continuing long after net entry into tenant status. All in all, it appears too early to rule out the agricultural ladder from American history.

On balance, the evidence is that tenant agriculture is efficient and that farmers choose different tenures deliberately, not randomly. Accordingly,

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\(^{15}\)In the postbellum South, cotton could most easily utilize child labor — especially in the harvest (cotton grows close to the ground). This might in some part explain why tenants grew proportionately more cotton.

\(^{16}\)Cash crops are typically less complex, if for no other reasons than the ready provision of cultivation advice and marketing services. This relative simplicity may explain some part of tenants' relative concentration on cash crops.
Table 16.7a

Average age, per cent and years of farm experience of farmers working current farm 1 to 4 years, 1920

<table>
<thead>
<tr>
<th>Current tenure</th>
<th>Reporting time as owner O, wage earner W, and tenant T</th>
<th>Reporting time as owner O and tenant T only</th>
<th>Reporting time as wage earner W only</th>
<th>Reporting time as owner O only.</th>
<th>Reporting time as tenant T only.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of row avg. age years as</td>
<td>% of row avg. age years as</td>
<td>% of row avg. age years as</td>
<td>% of row avg. age years as</td>
<td>% of row avg. age years as</td>
</tr>
<tr>
<td></td>
<td>O W T</td>
<td>O T</td>
<td>O W</td>
<td>O T</td>
<td>O T</td>
</tr>
<tr>
<td>Tenant¹</td>
<td>4.4 41.7 9.2 5.6 2.5 6.6 40.5 10.5 2.4</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
</tr>
<tr>
<td>Owner²</td>
<td>25.5 40.3 2.3 5.8 8.9 29.5 37.7 2.3 9.0 11.8 36.7 2.5 6.8</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
<td>— — — — — — — — —</td>
</tr>
</tbody>
</table>

¹p. 459, Table 27. ²p. 459, Table 26.

Table 16.7b

Average beginning age prior experience of farmers working current farm 1 to 4 years, 1920

<table>
<thead>
<tr>
<th>Current tenure</th>
<th>Beginning age</th>
<th>Prior experience as</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Owner</td>
<td>Wage earner</td>
</tr>
<tr>
<td>Tenant</td>
<td>29.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Owner</td>
<td>36.0</td>
<td>—</td>
</tr>
</tbody>
</table>

Source: Calculated from Table 16.7a.
Table 16.8
Per cent of farmers who are share tenants S, renters R, tenants T, or owners O in different age classes, races, and regions, 1910

<table>
<thead>
<tr>
<th>Region</th>
<th>Tenure</th>
<th>Age class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
</tr>
<tr>
<td>U. S. — All¹</td>
<td>S</td>
<td>24.0</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>62.1</td>
</tr>
<tr>
<td>U. S. — White²</td>
<td>S</td>
<td>21.0</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>68.2</td>
</tr>
<tr>
<td>South — All²</td>
<td>S</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>49.6</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>49.6</td>
</tr>
<tr>
<td>South — White²</td>
<td>S</td>
<td>28.9</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>60.1</td>
</tr>
<tr>
<td>South — Nonwhite²</td>
<td>S</td>
<td>43.2</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>75.3</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>24.6</td>
</tr>
</tbody>
</table>

¹U.S. Census of Agriculture: 1920, Table 3, p. 351.
²Ibid., Table 5, p. 353.
Table 16.9
Per cent of farmers who are tenants in each age class, selected years

<table>
<thead>
<tr>
<th>Year</th>
<th>All</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890</td>
<td>34.1</td>
<td>67.4</td>
<td>50.2</td>
<td>36.0</td>
<td>21.7</td>
<td>17.8</td>
</tr>
<tr>
<td>1900</td>
<td>35.6</td>
<td>72.2</td>
<td>54.7</td>
<td>35.6</td>
<td>29.3</td>
<td>21.0</td>
</tr>
<tr>
<td>1910</td>
<td>37.0</td>
<td>75.6</td>
<td>53.0</td>
<td>37.3</td>
<td>26.8</td>
<td>21.1</td>
</tr>
<tr>
<td>1920</td>
<td>38.1</td>
<td>75.8</td>
<td>56.5</td>
<td>39.7</td>
<td>30.2</td>
<td>20.7</td>
</tr>
<tr>
<td>1930</td>
<td>42.4</td>
<td>86.5</td>
<td>67.0</td>
<td>46.3</td>
<td>34.6</td>
<td>24.7</td>
</tr>
<tr>
<td>1940</td>
<td>38.6</td>
<td>79.0</td>
<td>64.1</td>
<td>45.9</td>
<td>32.9</td>
<td>24.6</td>
</tr>
<tr>
<td>1950</td>
<td>26.3</td>
<td>71.8</td>
<td>47.1</td>
<td>30.6</td>
<td>21.0</td>
<td>14.6</td>
</tr>
<tr>
<td>1959</td>
<td>19.8</td>
<td>65.9</td>
<td>42.0</td>
<td>25.5</td>
<td>17.7</td>
<td>11.8</td>
</tr>
<tr>
<td>1964</td>
<td>17.1</td>
<td>40.4</td>
<td>22.1</td>
<td>15.6</td>
<td>11.1</td>
<td>6.0</td>
</tr>
</tbody>
</table>


Table 16.10.
Net entry rate of farm operators by ages and tenures, selected years

<table>
<thead>
<tr>
<th>Begin — end of period</th>
<th>Age class</th>
<th>All</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
</tr>
</thead>
<tbody>
<tr>
<td>All farmers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890-1900</td>
<td>1850</td>
<td>4.47</td>
<td>.30</td>
<td>.10</td>
<td>-.16</td>
<td></td>
</tr>
<tr>
<td>1900-1910</td>
<td>.126</td>
<td>4.14</td>
<td>.32</td>
<td>.02</td>
<td>-.27</td>
<td></td>
</tr>
<tr>
<td>Tenants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890-1900</td>
<td>.238</td>
<td>3.43</td>
<td>-.08</td>
<td>-.11</td>
<td>-.37</td>
<td></td>
</tr>
<tr>
<td>1900-1910</td>
<td>.171</td>
<td>2.91</td>
<td>-.10</td>
<td>-.23</td>
<td>-.47</td>
<td></td>
</tr>
<tr>
<td>Owners</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1890-1900</td>
<td>.158</td>
<td>6.61</td>
<td>.68</td>
<td>.21</td>
<td>-.09</td>
<td></td>
</tr>
<tr>
<td>1900-1910</td>
<td>.085</td>
<td>7.13</td>
<td>.79</td>
<td>.14</td>
<td>-.19</td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed from Fourteenth Census of Agriculture, 1920, Table 6, p. 354.
economists now are concerned with the causes of tenure choice as well as with the consequences. And not surprisingly, recent explanations of the demand for and supply of different tenures use the building materials of the agricultural ladder: different allocations of risk and of human and physical capital between laborers and landlords combined under different tenures.¹⁷

As is well known, in his seminal analysis of Chinese tenancy, Cheung (1969) identifies differences among tenures in transaction (negotiation and enforcement) cost and in allocations of risk between tenant and landlord as the determinants of tenure choice. Cheung (1969, Ch. 4) argues that the transaction cost of a share lease exceeds that of a fixed wage or a fixed rent agreement, but that as the sharing of agricultural risk between the laborers and landowners becomes more desirable (as yield variance increases), share leases will be used increasingly to effect that sharing. Thus, the extent of sharecropping will vary positively with yield variance and inversely with a share contract’s relative transaction cost.

Cheung, then, is the first modern investigator to recognize that an analysis of tenure efficiency requires an explanation of tenure choice. Without doubt, however, his analysis of tenure choice is too simple. In fact, there is little correlation between yield variance and the popularity of sharecropping in America (Higgs, 1973; Reid, 1973) or elsewhere (Rao, 1971). In theory, there is little reason for there to be such a correlation (Reid, 1975, 1976b; Stiglitz, 1974): measured yield variance is a poor measure of farming risk, farming on shares is not the only way for laborers or landowners to reduce risk, share arrangements facilitate ends other than risk sharing — ends whose desirabilities fluctuate across time and place — and the relative costs and benefits of risk dispersion fluctuate as well (Wright and Kunreuther, 1975).

To see the force of these criticisms, let Cheung’s (1969, pp. 16-27) omnipotent landlords who freely set their share tenants’ share rates and labor intensities become more realistic landlords who seek labor within a competitive market wherein: returns to scale are constant, everyone (landlord and laborer) strives to maximize his welfare, and everyone may do so with share, rent, and wage agreements. For the moment, let all agreements be costless to transact and let yields be certain. Then, each landlord’s ability to rent his land insures that no landlord accepts a crop share of less than the market rent, while each landlord’s ability to farm his land with hired labor insures that no landlord accepts a rent less than his residual from owner cultivation. For like reasons, each laborer requires a crop share at least as great as his residual from rented land, and requires that residual to be at least as large as his foregone wages. Thus, competition among laborers for land and among landlords for labor implies a market wage rate, rental rate, share rate and intensity of share labor such that neither labor’s nor land’s return is

¹⁷In contrast to the original builders, however, modern investigators do not presume any innate desire of tenants to climb the ladder.
affected by the tenure under which it is employed. Furthermore, the distribution of labor or land among different tenures will be inconsequential.

When agricultural income is subject to irreducible uncertainty, these conclusions are unchanged (Reid, 1976b; Stiglitz, 1974). In that case, the market equilibrium is additionally characterized by a market risk premium. Since none need pay more to avoid risk nor accept less to bear risk than the market risk premium, the expected incomes available to each are his certain income (foregone wages for laborers, foregone rents for landlords) plus the market risk premium multiplied by the risk borne. In particular, share arrangements are unneeded to disperse risk: if, for example, a laborer devotes all of his effort to sharecropping for a share $b$ of the product, his expected income and risk will be the same as they will be if he devotes $b$ of his effort to renting and $(1 - b)$ of his effort to working for wages. Hence, when alternative means to disperse risk are available to landlords or tenants, such as abilities to employ part of their resources under for wages cultivation and part under fixed rent agreements, there are no determinate relations between the extent of share tenancy and the amounts of irreducible risk or the relative degrees of risk aversion of laborers and landlords. This conclusion is strengthened by noting that risk can be reduced at the farm, as well as dispersed, even when individual crop yield variances are irreducible: imperfectly correlated crops (such as cotton and corn in the postbellum South or corn and soybeans in the modern corn belt) can be grown, part of labor can be employed in off-farm jobs (currently, over one half of American farmers’ income comes from off-farm employments; based on preliminary analysis of the 1920 census, the proportion of farm operators who sharecrop is inversely related to the availability of off-farm jobs), and land can be mortgaged and the proceeds invested elsewhere.

In sum, it seems that sharecropping would be used to disperse agricultural risk only if the transaction cost of a share contract were less than the costs of the many other and oft-used means at laborers’ and landowners’ disposal to disperse or reduce risk. In newly settled areas, crop risks are not well known and employments whose returns are uncorrelated with crop yields are rare. Thus, the extensive use of share leases on new lands (A. Bogue, 1963; M. Bogue, 1959; Gates, 1973; Reid, 1976a; Winters, 1974) might well stem solely from the inestimable nature of the crop risks and the lack of other means to diversify. But the impetus to share tenancy in settled areas largely originates

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18 If an initially less risk averse laborer (landlord) is blocked from hiring in enough additional labor (land) to raise his demanded risk premium to the market risk premium, he will obtain a higher expected income and a more than proportional increase in uncertainty by renting (owner cultivating) only, and farming with a lower (higher) labor intensity than others. Perhaps a few such less risk averse renters and owners explain, in part, the findings that sharecropped lands are cultivated somewhat more intensively than owner cultivated lands, for sharecroppers are exactly as risk averse as the market (Reid, 1976b).
from sources other than risk aversion.\textsuperscript{19}

That a desire to disperse irreducible risk is an unlikely impetus to share tenancy does not mean that share tenancy and risk are unrelated. The essence of a share arrangement is the incentive it extends to all parties to the agreement — laborer and landowner in farming, employee and employer in business — to cooperate. At the same time, if a resource owner’s input contribution rate differs from his share rate, there remains the classical incentive to allocate inputs inefficiently. The suggested fundamental determinants of the extent of share tenancy, then, are the desirability of cooperation among resource owners, on the one hand, and the opportunity cost of getting that cooperation by other means, on the other. If cooperation between laborer and landlord can increase mean income or reduce risk, and if such cooperation can be achieved best under a share arrangement, then the extent of sharecropping and the potential for risk reduction will be positively related. Thus, it is not the extent of uncertainty, but rather the potential for risk reduction through cooperation which determines the extent of sharecropping in settled areas.

What risks in farming might be reduced through cooperation? One (most closely allied to yield variance) is natural risk. Agricultural production occurs over time, and, to some extent, effort at one time can substitute for effort at another: more fertilizer and closer cultivation can offset a poor planting, for example, and a more careful harvest can offset poor cultivation. Perhaps, more important, increased concentration on a crop unexpectedly favored by nature or markets can raise expected income and reduce income variability. But the most profitable variations of efforts across time and crops cannot be forecast, for agricultural uncertainty is reduced sequentially over the crop year. In such a sequentially uncertain environment, therefore, a tenant might well pay a premium to sharecrop rather than to rent, for a share landlord has a shared incentive to modify an initial lease so as to fully take advantage of sequentially reduced uncertainty: the share landlord more readily will ease contractual restrictions on crops and requirements for maintenance — and such clauses are common to both rent and share leases — and more certainly will help to provide newly wanted resources. Likewise, the landowners’ desire for share tenants plausibly is increased with sequentially reduced uncertainty, for share tenants more readily will redirect their efforts toward higher profits than will wage laborers. Thus, the nature of agricultural risk — the degree to which profitable responses can be made to its sequential reduction —

\textsuperscript{19}The suggestion is substantially reinforced by Wright and Kunreuther (1975), who report that the proportion of tenant (rent and share) farms in a county is more significantly related to the high real income risk crop (cotton) in the 1880 South than is the proportion of share farms. Indeed, running similar regressions on state aggregate data pooled from the 1880, 1890, 1900, and 1910 censuses of agriculture, I find that the proportion of share farms is not significantly related to the proportion of acreage devoted to cotton, but that the proportion of fixed rent farms is.
Sharecropping in American history

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determines the importance which landowners and laborers alike attach to cooperative contract modifications, and, therefore, to the incentives for cooperation implicit in a share lease; that agricultural risk will be reduced and that income will be cooperatively enhanced are more certain because the costs of nonoptimal responses are shared.

Even when nature is certain, such incentives for cooperation will be wanted by both laborers and landlords when both supply valuable inputs over the crop year. Incentives for cooperation help to coordinate the delivery of complementary inputs, and so to reduce the risk that one input will be disadvantaged by the absence of another. In the postbellum South, for example, laborers supplied a quality and quantity of labor over the crop year, while landowners supplied managerial assistance. Absent the whip and likely much reduced in proportion to laborers by the Civil War, southern farm managers found laborers on shares more likely to stay through the harvest and less needful of ever-present guidance than were hired hands (Hilgard, 1884: Reid, 1973; Shlomowitz, 1975). Similarly suggestive of landowners supplying managerial assistance, Higgs (1974) reports that postbellum Georgia landowners with larger holdings disproportionately let their lands on shares.

Winters (1974, p. 141, Table 5) shows that resident landlords in postbellum Iowa employed share leases at one-and-a-half times the rate of nonresident but instate landlords. Analyzing the 1920 census, Turner (1926, pp. 28-9) finds that absentee landlords leased out their land for fixed rents more frequently than resident landlords. There is no direct evidence on the importance of managerial assistance to share tenants. However, there is evidence of the considerable value of knowledge about individual farm characteristics and local weather conditions to farmers (Debertin, Harrison, Rades, and Bohl, 1975; Havlicek and Seagraves, 1962) — knowledge which a share contract would stimulate the landlord to share with his tenant. As reported above, American tenants are younger and less experienced than owners, on average, and therefore are plausibly in want of managerial assistance, and surveys commonly reported a desire for managerial assistance, as well as a desire to disperse risk, among tenants’ reasons for share renting (Englehorn, 1938, p. 82; Salter, 1943, p. 27).

Desire to minimize the risk of noncooperation through share contracts stands out equally clearly in Burrough’s (undated) description of Philippine share tenants who perform all labor unassisted and unguided, while their landlords purchase, finance, and deliver inputs (costs shared), and transport and most opportunistically sell the outputs (revenues shared). Here, too, tenants

20Such findings may reflect the greater cost to a nonresident landlord of stopping a share tenant from shirking, rather than the lesser ability of a nonresident landlord to render managerial assistance to tenants. The shirking explanation seems inconsistent with nonresident out-of-state landlords employing the share lease as frequently as nonresident in-state landlords did, however, and the share-improvement lease even more frequently, for the policing costs of a share contract were surely higher for out-of-state landlords (Winters, 1974, p. 141).
and landlord-agents insure the coordination of their specialized activities through share leases. In sum, when complementary factors may be profitably coordinated in ways difficult or costly to specify in advance (as when agricultural uncertainty is reduced sequentially) or in ways costly to supervise at the time (as when the inputs are profitably specialized), the modern approach to tenancy implies that share arrangements will be used to guarantee that coordination.\textsuperscript{21}

In addition, the implication of cooperation in a share arrangement will likely prompt less well known or less wealthy laborers to prefer sharecropping to renting, even if they desire no flexible, continuing assistance. This is because share leases tie the tenants' fortunes to their better known landlords, and thereby plausibly lower the tenants' finance costs. More to the point, profitable technological innovations, especially those which increase the managerial complexities of farming and substitute for land rather than for labor (such as do improved fertilizers, pesticides, and seeds) will likely be adopted more readily by share tenants — whose landlords will advertise, advise, and oversee the innovation. Such technological change will increase the extent of share tenancy as well.\textsuperscript{22}

Obviously, to substitute "desirability of cooperation" for "desirability of risk dispersion" in a discussion of tenure choice neither constitutes a full model of tenure choice nor demonstrably explains the causes and consequences of tenancy in American history. To adequately model tenure choice, what is wanted is a market equilibrium model that formally incorporates: (1) the nature of seasonal and annual wage employments available, and (2) the transaction costs of alternative contracts, with special attention to any non-competitive market power that might not extend across tenures (such that a landlord at some time and place might be able to differentially exploit wage workers and sharecroppers, perhaps because of some institutional quirks). More important, as I hope I have demonstrated, an adequate model of tenure choice must recognize (3) the heterogeneity of land and labor, and (4) the different types of risk faced by farmers: sequentially reduced risk versus irreducible risk, and coordination risk versus natural risk. To explain the role of tenancy in American history, one must use that model to infer the efficiency implications of historical changes in agricultural policy and in other constraints facing farmers, as well as to infer the hidden constraints facing farmers from the historical efficiencies of different tenures. To take some simple examples of the questions to be asked: did blacks' disproportionate

\textsuperscript{21} And in industry, as well. See Alchian and Demsetz (1972) and Groves (1973).

\textsuperscript{22} Technological changes which facilitate labor's supervision, such as the assembly line in industry or labor saving mechanization in agriculture, will reduce the extent of share tenancy (Day, 1967).
representation in share tenancy in the postbellum South reduce blacks' incomes or their incomes' rates of growth? And if the answer is "yes" to one or the other question, then why? Is it because share tenancy facilitated their exploitation, as Ransom and Sutch (1972, 1973, 1975) argue? Or is it because it facilitated their staying in a declining industry, the southern cotton farming? The list of questions is long, and they require a theoretical framework for answers.

If emphasis on cooperation does not constitute a full model of tenure choice, it certainly points in the right direction. And just as clearly, that direction is back to the agricultural ladder — that is, to an explanation of the demand for and supply of all tenures: wage work, sharecropping, renting and owning. Further, a desire for cooperation promises an economic rationale for farm ownership other than a hope for capital gains or a desire for status; if one person owns all of the inputs, then coordination can be costlessly sure. Finally, to recognize sure input coordination as the payoff to ownership suggests that part of the income loss from seemingly suboptimal owner operated family farms (when compared to tenant operated farms) be interpreted as a risk premium foregone by small owner operators, and not as a status premium (cf. Schultz, 1940).

Finally, we reach a policy conclusion likely to be valid for American history and the contemporary underdeveloped countries. The different tenures are efficient ways to associate three factors of production, land, labor, and capital. Capital includes human capital, and is typically owned in differing degrees by both landowners and laborers. The different tenures result from these differing degrees of ownership of human capital; different tenures arose and continue in order to efficiently allocate this scarce resource. As the level and rate of change of agricultural technology increase, this human capital becomes more scarce and, therefore, more important to utilize efficiently. Therefore, to restrict any tenancy, but especially to restrict share tenancy — through land reform legislation, say — is to hinder the sharing of human capital in agriculture and, thereby, to reduce efficiency.
Chapter 17

Sharecropping, risk sharing
and the importance
of imperfect information

David M. G. Newbery and Joseph E. Stiglitz

1. INTRODUCTION

Share tenancy contracts are common in Asia, Latin America and parts of the U.S.A. and are not unknown in Africa and Europe. The institution has survived Adam Smith’s strictures by two centuries, although it is increasingly under attack by land reformers and legislators who have doubtless been schooled in the Marshallian tradition to view sharecropping as a traditional and inefficient system of tenure. Is the conventional criticism of sharecropping valid, or do share contracts have advantages which are worth preserving? Is the decline in share tenancy in most developed economies a reflection of the abandonment of traditional methods of agriculture or is it a response to changing economic factors, such as changes in risk, land-labor ratios and capital intensities?

Our approach to these questions is first to present several alternative explanations of sharecropping, and to use them to derive empirical predictions. We shall then summarize some of the stylized facts concerning sharecropping which will allow some estimate of the relative importance of these alternative explanations. We shall argue against the two extreme views, the earlier Marshallian view which ascribes no economic rationale to sharecropping, and the more recent view which sees sharecropping as an effective risk sharing institution in a risky agricultural setting. Were risk sharing the only explanation, a number of the “stylized facts” of sharecropping economies would be left unexplained. In our analysis, incentives and imperfections of information play a critical role in the analysis of sharecropping.

Although this chapter is not primarily concerned either with an evaluation of the efficiency of the market or of alternative policies, such as land reform
and abolition of share tenancy, our analysis has certain welfare and policy implications upon which we shall comment briefly. In particular, we shall argue that the presumption that the market is efficient, implicit or explicit in much of the recent literature, is incorrect, or at least not persuasive. The conditions under which sharecropping has an economic rationale (e.g., costly information) are precisely the conditions under which not only are the conventional proofs of the Pareto optimality of the market economy not valid, but, more importantly, in other similar situations, the market solution is in general not even a constrained Pareto efficient allocation (Stiglitz, 1977.)

There are two basic themes running through this chapter. One, markets and institutions cannot be analyzed in isolation. One cannot understand share tenancy without at the same time considering the market for wage labor and the rental market for land; nor can one understand the credit market without taking into account the land market. Two, the fact that information is costly is critical for understanding behavior in these and other markets.

In most of the chapter, we shall focus on economies in which there are at least three kinds of contracts available: a wage contract, in which the landlord hires laborers, and pays them a fixed wage; a rental agreement, in which the worker pays the landlord a fixed payment, and keeps the residual between the output and the fixed payment; and a sharecropping agreement, in which the output is divided in some proportion between the landlord and the worker. In the first part, we shall assume that the only two factors of production are land and labor; subsequently, we shall consider other factors of production.

2. SHARECROPPING AS RISK SHARING

2.1. The Basic Argument

The most obvious explanation of sharecropping is that it provides a method by which the inevitable risks of agricultural production can be shared between the worker and the landlord, in much the same way that the stockmarket provides a method by which the risks in manufacturing can be shared between the suppliers of capital (the investors) and the entrepreneurs. If effort were inelastically supplied or the amount of labor effort could be specified in the contract, then this risk-sharing advantage of sharecropping would, according to this theory, lead to its dominance over rental and wage contracts. These risk-sharing advantages of sharecropping have to be offset against the incentive disadvantages, in determining whether sharecropping is or is not desirable.

For a more extensive discussion of this analogy, see Stiglitz (1974b).
This analysis, though plausible, has recently come under attack from two directions. On the one hand, it has been argued that the incentive (efficiency) problem can be dealt with in at least two different ways, thus eliminating the major alleged disadvantage of sharecropping. On the other hand, it has been argued that there may be no risk sharing advantages of sharecropping not already present in economy with rental and wage contracts, thus eliminating the major alleged advantage of sharecropping.

The traditional discussion of sharecropping focused on its incentive effects. Since workers received only a fraction of their marginal product, they would not be induced to work sufficiently hard, i.e., they would equate their share times the marginal productivity of labor to the marginal disutility of effort, rather than equating their marginal productivity of labor to the marginal disutility of labor.

Gale Johnson (1950) suggested two possible solutions to the potential inefficiency of sharecropping. The landlord could enforce the desired intensity of cultivation either by specifying in detail what the tenant was required to do, or by granting only a short term lease which would be renewed only upon satisfactory performance. Johnson discussed the second method, and elsewhere one of us has shown that this result holds up in the presence of risk (Newbery, 1975). Cheung (1969) and Reid (1973) have analyzed the first method and provided historical evidence that such contracts were indeed drawn up.

On the other hand, Stiglitz (1974b) and Newbery (1975) have argued that sharecropping may provide no additional risk sharing advantage over a mixture of rental and wage contracts.

The result is very general and does not require any restriction on the kind of production risk, nor of attitudes to this risk, nor does it require competitive behavior in the wage or rental markets. All we need to assume is that there is one single crop produced under constant returns to scale, and that there is no uncertainty about the terms of the wage and fixed rent contracts. Assume for the moment that the input of labor can be costlessly observed and specified in the labor contract. The share tenant's income for an input of labor $L$ on land of area $T$ is

$$ Y_w = \alpha Q = \alpha F(L, T, \theta) \tag{1} $$

where $\alpha$ is the share assigned to labor, $Q$ is total output, and $\theta$ is the state of the weather and other hazards, a random variable which is not known until after the harvest.

The income of the landlord from this plot of land is his share

$$ Y_R = (1 - \alpha) Q \tag{2} $$
What we wish to show is that if this plot of land can be subdivided into two subplots, one of which is rented out at a fixed rental \( R \), and the other is operated by the landlord who hires labor at a wage \( W \), then there exist values of \( R, W \) and \( \alpha \) such that both the landlord and the tenant will be indifferent between sharecropping and this alternative. Constant returns to scale ensures that

\[
F(\alpha L, \alpha T, \theta) = \alpha F(L, T, \theta).
\]  

(3)

Then, if the share rental is set so that

\[
\alpha R = W(1 - \alpha) L/T
\]  

(4)

and if the landlord rents out a fraction \( \alpha \) of his land, then the worker's total income from allocating a fraction \( \alpha \) of his former time \( L \) to the fixed rent tenancy and the remainder to working for a wage will be

\[
[ F(\alpha L, \alpha T, \theta) - \alpha RT] + W(1 - \alpha)L = \alpha F(L, T, \theta)
\]  

(5)

and the landlord's income will be given by

\[
\alpha RT + F[(1 - \alpha)L(1 - \alpha)T, \theta] - W(1 - \alpha)L = (1 - \alpha)F(L, T, \theta)
\]  

(6)

so that they will receive exactly the same as with the sharecropping agreement. Notice that if (4) is not satisfied, equilibrium could not be attained in the three markets simultaneously, e.g., if

\[
\alpha R > W(1 - \alpha)L/T
\]

then the landlords would prefer renting a fraction of their land and hiring labor on the remainder to the sharecropping agreement, and conversely, all workers would prefer the sharecropping agreement.

Our argument shows that, assuming there are no higher transaction costs in negotiating share tenancies than wage and rental agreements, share tenancy offers no risk sharing advantages over a combination of wage and rental agreements. But is it reasonable to suppose that these transaction costs are not higher? Cheung, who believed that the risk sharing benefits of share contracts were limited by higher transaction costs, argued not "...contracting on a share basis appears to involve higher transaction costs as a whole (the sum of negotiation and enforcement costs) than a fixed rent or wage contract" (Cheung, 1969, p. 67). He concluded that "a share contract will be chosen rather than a fixed rent or wage contract is at least compensated for by the gain in risk dispersion." (Ibid, p. 69).
Thus, if Cheung’s judgments on transaction costs are to be believed, and if his belief that the incentive problem can be overcome is correct, it would appear, since we have shown that there is no gain in risk dispersion, that sharecropping would never occur.

We are thus forced to look for alternative explanations of sharecropping. Three categories of arguments deserve investigation. The first concerns risk sharing opportunities when there is more than a single source of risk; the second concerns imperfect information and incentive effects of sharecropping; and the third involves the use of inputs other than land and labor.

2.2. Risk Sharing with Multiple Sources of Risk

If the only kind of risk is production risk, then tenants can reduce their exposure to risk by working as laborers rather than tenants. However, in many parts of the world where agriculture is the major source of employment, the risk which affects agricultural production will also affect the labor market, and either wages, or employment, or both, will be risky. A tenant will sell labor in the casual labor market when the weather reduces the marginal product of labor on his tenancy to a value below the wage on the casual labor market, and will hire in from the casual labor market if the weather raises the marginal product above the wage in the casual labor market.

The consequences of this are most easily modelled by supposing that output risk is multiplicative. Let \( f(x) \) be output per acre, a function of labor intensity, \( x; x = L/T \). Then we have

\[
Q = F(L, T, \theta) = T \theta f(x). \tag{7}
\]

The wage rate is a random variable \( W \); \( \theta \) and \( \varphi \) are random variables with mean unity. If agents maximize the expected utility of consumption \( EU(Y_o) \), and if agents are limited to choosing wage and fixed rent contracts alone, then

\[
Y_o = \theta T f(x) - R T + \varphi W(L - T x) + R \bar{T} \tag{8}
\]

where \( \bar{T}, \bar{L} \) are the endowments of labor and land owned by the agent. The agent chooses \( \{x, T\} \) to maximize expected utility, yielding the first order conditions

\[
EU'[\theta T f'(x) - \varphi W T] = 0 \tag{9a}
\]

\[
EU'[\theta f(x) - R - \varphi W x] = 0 \tag{9b}
\]

or, rearranging,

\[
f'(x) EU' \theta = W EU' \varphi \tag{10a}
\]
\[(f - xf') \ EU' \theta = REU'. \quad (10b)\]

If wages are certain, so \( \phi = 1 \), then

\[
\frac{f'}{f - xf'} = \frac{\text{MP Labor}}{\text{MP Land}} = \frac{W}{R}
\]

and these marginal products will be equated everywhere, their rates being the common ratio of the factor prices. If \( \phi \) is perfectly correlated with \( \theta \), then again marginal products will be equated everywhere.\(^2\) If individuals are risk averse,

\[
R = (f - xf') \ EU' \theta / EU' < (f - xf').
\]

If \( \phi \) is not perfectly correlated with \( \theta \), then marginal products will not in general be equated, for \( EU' \phi / EU' \) will differ from agent to agent, depending on his beliefs, risk preferences, and wealth.

Now suppose agents can sign share rents defined by \((\alpha^*, x^*)\) so that their consumption is

\[
Y_w = T^1 \left[ \theta f(x) - R - \phi \bar{W}x \right] + T^2 \left[ \alpha^* \theta f(x) - \phi Wx^* \right] + T^3[(1 - \alpha^*) \theta f(x^*) - R] + (R \bar{T} + \phi \bar{W} \bar{L})
\]

where \( T^1 \) and \( T^3 \) are rented at fixed rent, \( T^2 \) at share rent, and \( T^2 \) is sublet at share rent. If agents choose \( T^1 \) and \( x \) to maximize expected utility the solution must satisfy

\[
f'(x) \ EU' \theta = WEU' \phi, \ (f - xf') \ EU' \theta = REU'.
\]

\[
\alpha^* f(x^*) \ EU' \theta = Wx^* \ EU' \phi, \ (1 - \alpha^*) f(x^*) \ EU' \theta = REU'.
\]

which has the unique solution \( x = x^*, \alpha^* = \rho^* \) where \( \rho^* \) is the inputed share of labor in output evaluated at \( x^* \), i.e.,

\(^2\)If \( \phi = a \theta + b \), then eliminating expected marginal utilities yields \( R(f' - aW) = b\bar{W}(f - af') \) which uniquely defines \( x \).
\[ \alpha^* = \frac{x^* f'(x^*)}{x^*} \equiv s^* \quad (13) \]

In a competitive economy, share contracts thus provide the means for all farms to equate marginal products on all operated land, for the terms of the share contract must be the same for all farmers in competitive equilibrium, and the return to the share contract is perfectly correlated with all production, given the assumption of multiplicative risk. Far from sharecropping being a source of allocative inefficiency, when labor markets are risky, share contracts can eliminate inefficiency, essentially by creating another market in production risk. ³

Thus, although share contracts offer no risk sharing advantages when risk is confined to production, they allow the economy to increase output in every state of nature if factor markets are risky. As we shall see, this is an example of a general proposition that sharecropping can only be understood by focusing on the input markets, and is a response to inadequacies in these markets. Here, the labor market is unable to provide needed insurance, and sharecropping emerges in response as a partial solution.

One natural interpretation of the random wage is that some part of the labor force is hired after information concerning the productivity of labor is known (i.e., after \( \theta \) is known). This "uncommitted" labor force will receive its marginal product, which is random. In that interpretation,

\[ \alpha = \varphi, \]

all farmers will hire labor (in or out) to the point that

\[ \theta f'(x) = W' \varphi \]

so there is production efficiency and sharecropping provides no additional risk sharing opportunities not already in the market.

³ The same result also holds in the absence of wage uncertainty, and it has the interesting implication that the competitive share rent will be constant and equal to the land coefficient if production is described by a Cobb-Douglas production function. Casual empiricists, thus, have an easy time identifying the production function where there is competitive sharecropping, and the stability of shares in rental agreements need not be a sign of the inertia of tradition, only that agents cannot distinguish the true production function from a Cobb-Douglas approximation. Can we do any better?

⁴ Newbery (1977) provides a rigorous proof that the solution described above is unique, and that only one kind of share contract will be accepted in equilibrium.
More generally, so long as there is some wage contract which is a linear function of $\theta$, sharecropping provides no additional risk sharing opportunities. Thus, it is only if there are multiple sources of risk, which are reflected in the market wage, can sharecropping provide an additional instrument for risk sharing. Even then, it may not provide any additional instrument: for if the exogenous sources of uncertainty relate to the effect of weather on different crops, and if the individual who rents land can plant each of these different crops in any desired proportion, then, clearly this provides greater opportunities for choosing among alternative risky patterns of returns than can be provided by the mixing of sharecropping and the random wage (which can be thought of as a particular mixing of the exogenous sources of uncertainty). This would suggest that the importance of sharecropping for risk sharing requires mixing of crops to be infeasible for the farmer, mixing of wage labor and sharecropping to be feasible, and that the market wage is neither constant nor highly correlated with the exogenous sources of uncertainty in the area.

3. IMPERFECT INFORMATION AND SHARECROPPING

There are three distinct roles that sharecropping may perform when information is imperfect and costly.

3.1. Sharecropping and Incentives

First, whenever the worker receives for any task less than his marginal product, he has insufficient incentives for providing effort; and in all contracts except where he rents land, he receives less than his marginal product. But rental contracts force all the risk to be absorbed by the worker. This is what leads to the fundamental incentives problem. There are two alternative ways of reducing the shirking that is inevitable in a pure wage contract: either the worker has to be monitored (supervised), or some incentives need to be provided, i.e., the worker must receive some return for his provision of effort.

It is costly to monitor the inputs of workers; thus, although one could write contracts specifying the amount and nature of the labor effort which the worker is to supply in each possible contingency, the costs of drawing up such a contract and the costs of enforcement would be prohibitive. As a

\[\text{This includes the special cases of } \theta \text{ and } \phi \text{ being perfectly correlated and the case of a constant wage.} \]

\[\text{Because demand curves are not in general linear, the market wage will provide a nonlinear mixing of the exogenous variables; it may, thus, provide additional opportunities for risk sharing. We doubt, however, whether this is very important.} \]
consequence, all wage contracts employ imperfect and indirect monitoring systems; the wage system may entail either fairly close monitoring, or more infrequent monitoring, but with stronger penalties for differences between the contracted labor input and the actual labor input.

Alternatively, in the share contract, the worker receives some fraction of his marginal product; this provides some incentive for the allocation of his effort (though less than if he received the entire marginal product). However, if the costs of supervision are high, this may be a preferable way of managing labor. The terms of the sharecropping arrangement represent a compromise; contracts which provide greater incentives (i.e., relate his income more closely to the output), by their very nature force him to absorb more risk. On the other hand, contracts which provide greater incentives require less supervision and less need for monitoring the inputs of labor.

In this way of looking at sharecropping, output is an imperfect surrogate for measuring labor input. But output is more easily measured than inputs, and hence, it may be an efficient surrogate.

Notice, however, that in this wage contract, although labor input is not observable, the landlord would, in general, wish to put restrictions on alternative uses of labor, i.e., he would forbid the individual to sell his labor in the wage market, since obviously, that would affect his input of labor on his tenancy. In principle, moreover, since the amount of effort that an individual will apply to his land will depend on the size of his farm, his share should depend on farm size.

Remarkably enough, it turns out that if landlords are risk neutral and the production function is Cobb-Douglas, the level of effort is independent of the share, and the equilibrium share of labor is just the coefficient of labor in the production function. Thus, with the Cobb-Douglas production function, the predicted share when effort is unobservable and landlords are risk neutral is identical to the predicted share when effort is observable and landlords are risk averse. At this level of analysis, the two hypotheses are indistinguishable.

When the production function is not Cobb-Douglas, the level of effort does depend on the amount of land worked by the farmer, and the equilibrium share will depend on the elasticity of substitution and the elasticity of effort supplied by the farmer.

To see these results, let \( e \) be the level of effort, where the effective labor supply is given by

\[ eL \]

See also, Stiglitz (1974).
and let output per acre be a function of the effective labor supply per acre,
\[ z = \frac{eL}{T} = ex \]

i.e.,
\[ Q = \theta Tf(z) = \theta Tf(ex). \]  \(14\)

Then the income of a sharecropper is given by
\[ Y_w = \frac{\alpha \theta f(ex)}{x}. \]  \(15\)

The worker experiences disutility from effort, so that his net utility is
\[ U = Eu(Y_w) - v(e). \]  \(16\)

The contract specifies \((\alpha, x)\); the sharecropper then chooses \(e\) to maximize \(U\), and will only accept contracts which guarantee some base level of utility, \(U\):
\[ U(\alpha, x) = \text{Max } U \geq U \quad \{e\} \]  \(17\)

Competition between landlords will eliminate the less attractive contracts and leave equation (17) as an equality, which will define a relationship between \(x\) and \(\alpha\), and, since \(e = e(x, \alpha)\), between \(e\) and \(\alpha\). If landlords are risk neutral, they choose \(\alpha\) to maximize rent per acre
\[ Y_R = (1-\alpha) \theta f(ex) \]  \(18\)

subject to equation (17), i.e., subject to the relationships between \(e, x\) and \(\alpha\). In the appendix, it is shown that this gives
\[ \frac{\alpha}{1-\alpha} = \frac{s}{1-s} + \frac{s \alpha de}{ed \alpha \overline{U}} \]  \(19\)

where
\[ s = \frac{zf'(z)}{f(z)} \]  \(20\)

is the imputed share of effective labor. It is also shown that if the elasticity of substitution between effective labor, \(eL\), and land \(x\) is unity, the second term is zero. In this case the tenant receives his imputed share (essentially because his effort is constant);
\[ \alpha = s \]
But if the elasticity of substitution is less than unity, giving an individual a higher share and less land (to have him just as well off) reduces his effort (because of the strong diminishing returns), and thus the optimal share is in fact less than his imputed share.

This result is of some interest, for it perhaps provides an explanation for the small share of labor in most sharecropping arrangements. Traditional sharecropping arrangements have involved shares of workers of between one-half and two-thirds, while the share of labor under more modern conditions of production appears to be considerably greater. Does this mean that the production function has changed dramatically or that the effective labor-land ratio has decreased with an elasticity of substitution less than unity? Although the latter is possible, given the decline of the proportion of the population in the agricultural sector, for reasonable values of the elasticity of substitution, labor augmenting technological progress, and population increases, it does not seem plausible, at least as an explanation on its own. Our theory suggests that the share of labor would be less than the imputed share; the substitution of rental and wage arrangements for share tenancy would, in itself, lead to a perhaps substantial increase in the share of income received by workers.\(^8\)

Notice that if the elasticity of substitution is not unity, and the effort elasticity of different individuals is observable and differs, then the contract made with different individuals will differ, and there will not be production efficiency.

3.2. Sharecropping and Information: Its Role in Resource Allocation

There is a second distinctive informational role which sharecropping may play. Assume that the productivity of labor on the farm is random because of the weather, and that the laborer’s opportunity cost, perhaps what he could get as a casual laborer, is also random. Efficiency would require that the worker allocate his time at any moment to the use with the highest productivity. If the wage in the agricultural sector were always equal to the random marginal productivity, this would occur. There are, however, two problems. First, it may impose a heavy risk burden on the worker; secondly, and more pertinent to our present concern, the marginal productivity at any moment is costly to observe, hence the landlord is less informed about the marginal productivity than is the worker. Again, we have the same kind of tradeoff we noticed in our earlier discussion: a rental system provides the worker with all the correct incentives for allocating his labor, but imposes a

\(^8\) But not, of course, necessarily a proportionate increase in the welfare of workers, since they might be forced to absorb greater risks under rental contracts.
heavy risk burden on him; a wage system entails either close monitoring, to determine the value of the marginal productivity on a moment to moment basis; or a constant wage, with the resultant misallocation of labor resources. Sharecropping represents a compromise between these two systems.

The simplest model illustrating this is a straightforward generalization of our previous analyses. We assume that the worker can allocate a fraction of his labor supply, \( \gamma \), to the farm, and the remainder to the casual labor force, receiving there a wage \( w \). If \( x \) is the number of laborers hired per acre, and output per acre is given by \( \theta f(\gamma x) \) (we assume effort is inelastically supplied), then income maximization by the worker implies

\[
w = \alpha \theta f'(\gamma x).
\]  
(21)

We assume that \( \theta \) is observed by the worker but not by the landlord. Equation (21) provides the input of labor as a function of the random variable \( \theta \):

\[
\gamma = \frac{1}{x} f'^{-1}\left(\frac{w}{\alpha \theta}\right).
\]  
(22)

Thus, the income of the worker is given by

\[
(1 - \gamma)w + \alpha \theta \frac{f(\gamma x)}{x}
\]  
(23)

and that of the landlord by

\[
(1 - \alpha) \theta f(\gamma x)T.
\]  
(24)

The set of utility equivalent contracts is given by values \( (\alpha, x) \) such that

\[
EU \left[ (1 - \gamma)w + \alpha \theta \frac{f(\gamma x)}{x} \right] = U
\]  
(25)

i.e.,

\[
\frac{\alpha}{x} \frac{dx}{d\alpha} = \frac{f}{f - \gamma x f'}.
\]  
(26)

If the landlord maximizes expected income,

\[
\max_{\alpha} E \left(1 - \alpha\right) \theta f'(\gamma x) = (1 - \alpha) E f(\gamma x) \theta
\]

he chooses \( \alpha \) so that

\[
Ef\theta = \frac{1 - \alpha}{\alpha} E \frac{\theta f'}{1 f'''}
\]
Sharecropping and imperfect information

(using (26), or, upon using the definitions of \( s \) and \( \sigma \) (see (19) and the appendix)

\[
E \frac{\gamma x}{s} = \frac{1 - \alpha}{\alpha} \quad E \frac{\gamma x \sigma}{1 - s}
\]

(27)

Hence, if \( \sigma = 1 \),

\[
s = \alpha
\]

(28)

as in the previous model. If \( \sigma \) is constant, then to a first order of approximation

\[
\frac{\alpha}{1 - \alpha} = \frac{s}{1 - s} \quad \sigma
\]

(29)

i.e., the share of labor is less than its imputed share, if the elasticity is less than unity.

3.3. Sharecropping and Information: Its Role as a Screening Device

The third informational role of sharecropping is as a screening device. Different kinds of laborers have different productivities. The landlord would clearly like to have only the most productive workers working for him. Of course, if he rents the land, he is indifferent about the quality of labor, provided he can be sure that the rent gets paid and that the land is not damaged. If he pays a worker a fixed wage, screening is, of course, very important. Again, we have a tradeoff, between the risk which the worker is forced to absorb and the information required by the landlord. But not only does sharecropping represent a compromise between these various objectives, the availability of sharecropping actually results in more information being conveyed to the landlord: for the choice of contracts conveys information about the individual’s perceptions of his abilities; individuals who believe that they are most productive will choose the rental contract; individuals who believe they are very unproductive will choose the wage contract, and those in between will choose the share contract.

Assume we have three groups in the population, differing by productivity, denoted by \( v_1 > v_2 > v_3 \). Again, for simplicity, we assume the labor supplied by an individual is fixed at unity. Then, equilibrium, if it exists, can be characterized (assuming risk neutral landlords) by the following conditions:

(a) Workers of type 3 prefer wages to sharecropping or renting.

*Editors Note: This result has been derived independently by Hallagan (1977, 1978).
(b) Workers of type 2 prefer sharecropping to wages or renting.
(c) Workers of type 1 prefer renting to wages or sharecropping.
(d) If all workers allocate themselves in the indicated way, expected return per acre is identical for all plots of land.

Let the wage be \( w \); the share contract \( (\alpha, x) \) is the share, as before, and
\[
\frac{1}{\chi} = \frac{T}{L},
\]
the land per worker on sharecropped land, and \( R \) be the rent. Then condition (d) implies
\[
R = (1 - \alpha) f (v_2 x) = \max_{x} f (v_3 x) - w x_w \tag{30}
\]

Conditions (a), (b) and (c) may be written, assuming identical utility functions for all workers, as
\[
U (w) \geq EU (\alpha \theta f (v_3 x) / x) \tag{31a}
\]
\[
\geq \max_{x} U \left( \frac{\theta f (v_3 x) - R}{x} \right) \tag{31b}
\]
\[
U (w) \leq EU \left( \frac{\alpha \theta f (v_2 x)}{x} \right) \geq \max_{x} EU \left( \frac{\theta f (v_2 x) - R}{x} \right) \tag{31c}
\]
\[
\max_{x} \frac{\theta f (v_1 x) - R}{x} \geq EU \left( \frac{\alpha \theta f (v_1 x)}{x} \right) \geq U (w) \tag{31d}
\]

Since, in this model, there are no incentive problems, and landlords are risk neutral, the equilibrium (if it exists) is characterized by the sharecroppers absorbing as little risk as possible consistent with type 3 workers preferring the wage contract. Hence, we replace the inequality (31a) by an equality.

Hence, for a given \( w \), we obtain, from (31a), the set of utility-equivalent contracts for an individual of type 3
\[
\frac{d \ln \alpha}{d \ln x} = 1 - s \tag{32}
\]
where \( s \) is defined in equation (20), the “implicit” share of labor.

Given \( w \), we can solve (30) for the equilibrium rental on land,
\[
R = f [f^{-1} (w/v_3)] - \frac{w f'^{-1} (w/v_3)}{v_3}
\]
and for the locus of equilibrium share contracts (assuming that there is an equilibrium in which only type 2 individuals sharecrop)
\[
\alpha = 1 - R / f (v_2 x) \tag{33}
\]
\[
\frac{d \ln \alpha}{d \ln x} = \frac{1 - \alpha}{\alpha} s \tag{34}
\]
For a Cobb-Douglas production function, for instance, $s$ is constant, and the two loci appear as in Figure 17.1. Since as $\alpha \to 0$, the (RHS) of (34) approaches infinity, while as $\alpha \to 1$, the (RHS) of (34) approaches zero, the two loci (30) and (31a) intersect twice, but for our purposes, it is only the upper intersection which matters. This, or more accurately a point just below this,
provides the equilibrium share contract: at $E$, type 3 workers prefer the wage contract, and type 2 workers the share contract, while landlords receive the same expected rent regardless. Clearly, if $\nu_1$ is sufficiently great, (31d) will be satisfied as well.

Note that the equilibrium share is such that

$$\frac{1-\alpha}{\alpha} s < 1 - s$$

i.e.,

$$\alpha > s,$$  \hspace{1cm} (35)

the share of labor exceeds the implicit share along the production function.

This should be contrasted with earlier models where, for the Cobb-Douglas, the share was equal to the “implicit share.” In order to identify more production workers, the landlord gives each farmer a smaller plot of land and a larger share than he otherwise would.

But it is not only the choice among rental, wage, and sharecropping that conveys information concerning the worker. If a landlord were to offer a group of workers different sharecropping agreements, some providing greater land and a lower share, the more able would prefer a larger plot of land, if the elasticity of substitution were greater than unity and a smaller plot of land if the elasticity were less than unity. To see this, recall that an individual is indifferent among contracts for which, if effort were inelastically supplied

$$\frac{\alpha f'(\nu x)}{x} = \text{constant}.$$  \hspace{1cm} (36)

Thus,

$$\frac{T d\alpha}{\alpha dT} = 1 - s$$

where

$$s = \nu x f'(\nu x)/f(\nu x)$$

assigned to the worker. If we had two groups, then their indiffrence curves [in $(\ln \alpha, \ln T)$ space] appear as in Figure 17.2; clearly, if the landlord offers a set of contracts along the lower envelope, i.e., the heavily shaded curve, all the high ability workers will choose the larger plot in 2a and the smaller plot in 2b.

The locus of constant expected returns to the landlord is given by

$$(1-\alpha) f'(\nu x) = \text{constant}$$
Figure 17.2a. Equilibrium share contracts: high elasticity of substitution

Figure 17.2b. Equilibrium share contracts: low elasticity of substitution
or
\[ \frac{d \ln \alpha}{d \ln x} = -\frac{1 - \alpha}{\alpha} S. \]

The actual contract signed will be that which maximizes expected rent (if the landlord is risk neutral) for a given level of expected utility of the low ability worker. The two equilibrium contracts are \((\alpha^*, T^*_1), (\alpha^{**}, T^{**})\). At this pair, the low ability workers prefer their contract to any other contract offered, or which could be offered and yield the landlord the same rent. In Figure 17.2a, the high ability workers prefer their contract to any other contract offered, or which could be offered. In Figure 17.2b, they prefer their contract to the other contract — or to any other contract which could be offered which the low ability workers also did not choose. Notice that the presence of the low ability workers has induced the high ability workers to sign a share contract involving a higher share, more risk, and less land than they would have done in the absence of the less able.

Notice that in the latter case, where the elasticity of substitution is less than unity, smaller plots of land will always have higher outputs, while in the former case, where elasticity of substitution is greater than unity, the opposite may occur.

4. SHARECROPPING AND THE PROVISION OF OTHER INPUTS

Agricultural production requires more than just labor and land. Bullocks, tractors, fertilizer, seed, and other inputs are also required. This poses an important problem in any sharecropping economy. Who is to pay for these other inputs, and how much of these inputs are to be employed? Since, in general, neither the landlord nor the worker captures the entire value of the marginal product of a given input, if one or the other were required to pay the whole cost of the input, it would be undersupplied (the argument is identical to that for the supply of effort).

There are several alternative arrangements for dealing with these other inputs. If both landlord and workers were required to supply the inputs in the proportion of their shares in output, and if individuals were risk neutral, then since they would each bear the same fraction of the marginal cost as they would of the value of the marginal product, there would be complete agreement on the quantity of the given input to supply, provided they both face the same cost for the input. But if landlords and workers are risk averse (and differ in their degree of risk aversion, as one might expect), or if they differ in the cost of the input, then there will be disagreement concerning the
supply of the input. Thus, if \( \tilde{F}_z \) is the (random) marginal product of some input \( z \), which has a cost of \( p^w_z \) to the worker and \( p^R_z \) to the landlord, then the optimal supply from the worker's point of view will be

\[
\frac{EU^w_z \tilde{F}_z}{EU^w} = p^w_z
\]

and from the point of view of the landlord, it is

\[
\frac{EU^R_z \tilde{F}_z}{EU^R} = p^R_z.
\]

If, however, there is multiplicative uncertainty, *i.e.*

\[
Q = \theta F(z, x)
\]

for inputs \( z \) and \( x \), say, then, using the results of Section 3, we see that there will be agreement if the price of the input is the same even if their attitudes to risk differ. There is, however, one input for which the price will probably differ, and that is finance. And since the cost of finance differs, and since many inputs, like fertilizer and seed have to be used substantially before the date at which the return occurs, there would seem to be a *prima facie* case for landlords wanting more inputs to be used than the workers.

Cost sharing in the way indicated may not be a satisfactory solution, either because of the disagreements referred to earlier, or because it requires monitoring of the inputs, and this may be expensive. In that case, the burden of supplying the inputs may be imposed entirely on the worker or on the landlord. The analysis for this is identical to that for labor, when labor is unobservable. Indeed, the labor input is not really a single input; it can be thought of as consisting of "planting labor," "weeding labor," "harvesting labor," etc. We now add to the list "input of bullocks," "input of seed," etc. There is no difference in the analysis. An increase in the share received by the worker leads to greater incentives to supply all inputs, but imposes greater risk on the worker: the optimal contract is chosen to balance these two effects.

In the remainder of this section, we focus on three different kinds of inputs and their effect on the sharecropping contract.

The first category is those for which indivisibilities are important. This, we argue, does provide some argument for sharecropping.

Second, we discuss capital markets in more detail. The final section deals with the problem of managerial services, and in particular, with technological innovation.
4.1. Indivisibilities and Sharecropping

The argument of Section 3 that sharecropping was not necessary for risk sharing depends crucially on the assumption of land divisibility. If there are indivisibilities, then sharecropping may be important for risk sharing. If there are economies of scale in production, then sharecropping becomes attractive, because an acre of land under share rent is no more risky for the tenant than a acres of land under fixed rent. Holding risk constant, tenancies can be larger under share rent than fixed rent, and, with economies of scale, they will yield higher outputs per unit input.

The most obvious sources of economies of scale in agriculture arise because some inputs are indivisible. In some parts of the world (like Bihar, see Bell, 1975), there is no rental market in draught animal power, and any would-be tenant must invest in an indivisible team of oxen. In other parts of the world, like the Philippines, there is apparently a good rental market in ploughing services and the indivisibility does not arise. Where it does, there will be economies of scale up to the land area which can be handled by the minimum size team. The same phenomenon may arise in U.S. agriculture where tenants supply the tractors, and efficient tractor sizes are now extremely large.

It is not hard to think of reasons why the rental market in capital equipment should fail, for the problems of moral hazard are likely to be severe. It may be difficult to tell by inspection whether the renter has taken due care and attention, though this would seem to be less of a problem for draught animals than sophisticated equipment, and does not preclude purchasing the services of the equipment, where the owner operates it. Ploughing and harvesting are often done on contract. The other reason why the market may fail is that it is too risky. It may be difficult to specify in advance the contingencies under which draught animals will be needed on a given day in the future, and less risky for each farmer to provide his own equipment. If risk affects all farmers similarly (as in mono-agriculture) then the demand for the services of the equipment will be correlated. Either all farmers will have surplus capacity and there will be no demand, or there will be excess demand and no supply, and in both cases the market will experience no trade. One might conjecture that rental markets in equipment would be more likely the more diversified is agriculture, the more flexibility there is in the timing of operations, or the more pronounced are the indivisibilities. Increasing the temporal flexibility of crops, by making planting and harvesting dates less sensitive to the environment or by making a range of seed types available, may thus have a double effect on production — the direct one of giving the farmer greater flexibility, and the indirect one of stimulating markets which economize on indivisible inputs.

It is also worth noting that the argument that risky factor markets make share contracts attractive was illustrated for the labor market, but might more plausibly apply to other inputs, like draught power.
In the manufacturing sector, the main indivisibility may be the managerial team, and it is noticeable that owners issue equity to share risk, rather than engage in a wide range of uncorrelated activities which, under strictly constant returns, would provide an alternative solution.

4.2. Sharecropping and Capital Market Imperfections

In this section, we focus on the input “capital.” We are concerned with three questions:

(a) Why are contractual arrangements for the provision of this factor different from those for labor?
(b) Why is it that the lender of capital is so often the landlord?
(c) What would be the consequences, for the capital market, of a change in the form of tenancy?

Credit loans are generally not equity loans, that is, the repayment is not, in general, contingent upon the output of the farm. Often, they are repayable in grain at harvest time, in which case they are negatively correlated (in value terms) with the borrower’s output. Why do not better financial instruments emerge to share risk? One reason might be that the capital input is more easily observable than the labor input; a major explanation of the use of sharecropping was the unobservability of the labor input. Although the amount which an individual borrows may be observable (if there is only a single lender), the amount he uses for private consumption and the amount he uses for inputs to agricultural production are not, and hence the same observability problem arises.

Indeed, an equity loan, which would cause the share remaining to the worker to be reduced, would simply increase the problem of shirking; it would reduce the incentives for the application of both labor and capital. And since the loss from the disincentive increases with the square (in the usual quadratic approximation) of the difference between the marginal product of the worker and what he receives, the extra loss from an equity loan may be significant.

So far, however, the argument is symmetrical. We could have argued that capital be provided on a share basis, and the land be provided on a fixed fee basis. Are there any differences between the two that would explain their asymmetrical treatment?

There is one important difference: the maximum loss in the supply of land to the worker is the year’s rent on the land; if the worker is unable to pay the rent, the landlord still owns the land. But the maximum loss in the supply of capital is not only the “rent,” the interest on the capital, but the capital itself. This has two consequences. First, an equity loan may impose an undue risk on the lender, since if the crop fails he loses his entire capital. He would rather have the farmer continue to have an obligation to him, to repay him in some future year. On the other hand, it makes collateral more important. Although
this in itself does not explain the form of the contract, it does serve to explain why the lender and the landlord are often the same person.

If credit is productive, then the landlord collects a share of the entire product, and he has to monitor the contract to ensure its enforcement anyway, so that the extra cost of ensuring that the loan is used wisely is less than for any other agent. Moreover, the landlord is usually in the best position to judge the riskiness of different borrowers; he has more information concerning his tenants. It is not surprising that the offices of share landlords, and moneylenders are often combined (Bhaduri, 1973; Newbery 1975b), and it is not to be inferred that this is evidence of monopoly power.\footnote{Though something like monopoly power is inevitable wherever information is costly, for the owner of the information, the moneylender, say, will seek a return to this cost, and the cost will create a barrier to entry by competing moneylenders.}

If share landlords have a comparative advantage in lending to their tenants, the institution of share tenancy inhibits other moneylenders from lending to share tenants, for any equity loan will increase the incentive for the tenant to undersupply inputs, and the landlord will suffer. The landlord will thus try and prevent his tenant from borrowing from other moneylenders, and moneylenders will themselves find loans to share tenants riskier, since they will not have the first claim on the crop. The converse is true in the capital market where debt has precedence over equity. Sharecropping may thus both be a response to moral hazard in the credit market and an impediment to expanding credit.

The problem of default may also predispose landlords to offer share rather than fixed rent tenancies. In a monetized economy, a share rent is easy to collect at harvest time, since it is a well defined fraction of the harvest no matter what price prevails. A fixed cash rent may be more difficult to collect. If the crop is hypothecated and the tenant defaults, the landlord has no incentive to find the best price for the crop, only a price which covers the rent. The tenant will thus be reluctant to hypothecate his crop, and cannot offer collateral against defaulting on the rent. In short, transaction costs may be lower for share contracts than fixed cash rent contracts.\footnote{This seems to be the case in U.S. agriculture, judging from our most illuminating conversation with Glenn Johnson.} Of course, the problem does not arise if the rent is fixed in kind, but this reduces the freedom of the tenant to choose his cropping pattern, an advantage available to a cash rent tenant.

From these remarks, it should be clear that the effect of land reform on the provision of credit is probably positive. On the one hand, it may increase the potential collateral of the borrowers; the increase in collateral not only makes loans less expensive, it also reduces the degree of monopoly power exercised by the former landlord because his differential information concerning the riskiness of different lenders simply becomes less important.
the other hand, if the lender is not allowed to attach the land, he can still attach the crop, and thus his incentives are at least as great as when he owned the land, but one of the major disadvantages of providing equity loans, that it increases shirking beyond an acceptable level, is removed.

4.3. Supply of Managerial Inputs and Induced Modernization

It has sometimes been argued that sharecropping reduces the rate of dissemination of new techniques. The argument is the familiar one: the landlord is presumed to be better informed than the worker; the marginal return he obtains to providing the information is, however, less than the social marginal return, and hence he has inadequate incentives for providing the information. On the other hand, the tenants, having different (more pessimistic or more uncertain) estimates of the returns to the innovation, resist its introduction.

Obviously, in the situation where the landlord and worker negotiate all the terms of the agreement, including the landlord's provision of managerial inputs, no real problem arises. The difference in expectations concerning the returns to the innovation is simply an argument for more of the risk to be absorbed by the landlord.11

The dissemination of innovations provides another argument for using wage contracts: a major advantage of the sharecropping agreement was that it substituted incentives for direct supervision: but if direct supervision is required connected with modernization, there may be little extra cost associated with ensuring that workers provide the agreed level of effort.

Moreover, since there is inevitably a great deal of uncertainty associated with the provision of information by the manager, a sharecropping agreement imposes this additional uncertainty on the worker; and even if such agreements could be signed, they would be difficult to enforce since it would be impossible to identify whether the reason that the manager has failed to supply any new information is that, in fact, no new developments had occurred or because he was failing to fulfill his part of the contract.

5. THE STYLISTIZED FACTS

The previous section identified several alternative explanations for sharecropping. Here we present several “stylized facts” of sharecropping economies and attempt to contrast these stylized facts with what the alternative theories predict.

11 The argument is formally identical to the analysis of corporate financial structure, when the entrepreneur and the lender have different estimates of the return to the project; the more optimistic individual absorbs more of the risk than he otherwise would have since the gain to him thereby is greater (in his judgment) than the loss to the pessimistic individual (see Stiglitz, 1972).
The first important stylized fact is the persistence of sharecropping under a variety of conditions over centuries of time, in particular its persistence in the presence of rental and wage markets. This persistence provides, for us, a convincing argument against the simple risk sharing argument presented in Section 2; for although sharecropping might be found in the absence of rental and wage markets, it would presumably never be found to coexist with them.

The second stylized fact is that share tenancy is often, but not always associated with lower productivity than rental land. (Bell, 1977, made the most satisfactory empirical investigation.) This would never be the case if these models, which said that labor input was observable and enforceable, were true. But this observation is consistent with all three of our information arguments for sharecropping. In the first, the incentive argument for sharecropping, differences in productivity are likely to be small if the production function is close to a Cobb-Douglas production function; hence, differences in productivity support the relative importance of either the allocation function of sharecropping or the screening function of sharecropping.

The third stylized fact is that in many economies there is a preferred share agreement, that is, the percentage division between the landlord and the worker does not vary from contract to contract; it does not seem to be the object of negotiation. This is hard to reconcile with the simple risk sharing with observability of labor input view which ignores the mixing of rental and wage markets as an alternative method of risk sharing since one would expect different degrees of risk aversion on the part of different workers to result in different contracts.

If, however, individuals can mix rental, wage and sharecropping contracts, we showed (Section 3.2) that there would be a single sharecropping agreement, but even if inputs (hours worked) were observable, if ability were not perfectly observable (as it clearly is not), then the share would still be a function of the amount of land farmed since that could be used as a screening device.

Alternatively, we argued that if the reason for sharecropping were the provision of incentives, with labor effort being unobservable (although in general the terms of the contract would depend on the effort elasticity of the worker and his degree of risk aversion), if the production function is Cobb-Douglas, then there is a single share agreement that would be signed by all individuals. But in those conditions, productivity would not be a function of the size of farm.

If sharecropping were performing the other informational roles discussed above, there is some presumption that there ought to be several alternative sharecropping agreements, with the share depending on the amount of land farmed by the individual. The fact that they do not may result from the fact that in certain special cases, the optimal share may not be very sensitive to the variations occurring within the population.

The fourth stylized fact is that in modern developed economies, there appears to be a decline in share tenancy. We must ask why? Clearly, there is
no evidence of a decline in the relative magnitudes of the risks involved; several of the changes in agricultural production (e.g., shifting to single crop farming) have probably increased the risks, in a relative sense. The lowering of transport costs has probably imposed greater price risks on farmers; that is, since in a closed economy, prices and quantities produced vary inversely, incomes of farmers vary less than outputs vary and hence, opening trade increases the variability of income. Nor is there any strong evidence of declining (relative) risk aversion; indeed, some have argued that relative risk aversion increases with wealth. The simple risk-sharing argument again seems inconsistent with this stylized fact. We would put forward four explanations: a) improvements in markets for rented capital goods (e.g., tractors) have reduced the importance of indivisibilities; b) with more capital intensive techniques, it has become more important to have appropriate labor incentives of the kind provided by rental agreements; (c) the more capital intensive techniques have reduced the managerial problems associated with the wage labor system; and (d) the more rapid rate of innovation has increased the relative attractiveness of wage/rental systems.

An explanation of sharecropping should not only “explain” the stylized facts of the use of sharecropping contracts in preference to or in conjunction with wage and rental contracts. It should also, in principle, be able to explain why other contractual arrangements were not employed. For instance, if risk sharing were the primary objective, we need to ask, ‘do there not exist alternative risk sharing arrangements having most of the virtues of sharecropping without some of the more important defects?’

Consider, for instance, the conflict we have repeatedly noted between the objectives of risk sharing and incentives. The problem of having a perfect risk sharing device arises from the unobservability of $\theta$, the exogenous source of uncertainty. Output is used as a surrogate for $\theta$, but output depends on $\theta$ and effort. This is the source of the conflict. But if other farmers’ output also depends on $\theta$, one could make the individual’s payments to the landlord a function of others’ output; this would eliminate the incentive problem but provide complete risk sharing if $\theta$ were perfectly correlated for all farmers. That is, the $i$th farmer’s income would be

$$(Q_i - (1 - \alpha) \bar{Q} - j)$$

where $Q_i$ is the $j$th farmer’s output and $\bar{Q} - j$ is the mean output of all farmers other than $j$. If there is multiplicative uncertainty, such that

$$Q_i = \theta F(L_i)$$

12 This suggests that the growth of protectionism may have a strong economic rationale. The lowering of transport costs imposed greater risks on farmers; they responded by attempting to replace the natural protection provided by high transport costs by artificial protection.
then, if there are \( n \) identical farmers
\[
Y_w^i = \theta F(L^i) - (1 - \alpha) \sum_{j \neq i} \theta F(L^j)/n.
\]
In equilibrium
\[
Y_w^i = \alpha \theta F(L^i)
\]
\( i.e. \), the amount of risk borne by the individual farmer is exactly the same as under the conventional sharecropping agreement; but now the individual receives his entire marginal product so that if \( v(L) \) represents his disutility to labor then
\[
EU'(Y_w) \theta F' = v'.
\]
as opposed to, with conventional sharecropping arrangements,
\[
\alpha EU'(Y_w) \theta F' = v'.
\]
Thus, the incentive problem has been eliminated.

The essential feature of this contract is that it makes payments a function of "market conditions" rather than the performance of the particular individual. Such contracts are useful, so long as there exist some easily identifiable "market conditions" which are correlated with the risks facing the individual. Many contracts have provisions which make payments a function of general conditions: escape clauses in the presence of general disaster are a particularly important class of examples. But they are not as prevalent as one might have thought, given the emphasis we have placed throughout our analysis on the conflict between incentive and risk problems. We need to ask why.

Several explanations offer themselves. One may be simply the lack of cleverness of landlords; they simply did not think of designing such contracts.

In this view, the above proposal is an innovation, like any other marketing innovation; there is no reason to believe that traditional economies had explored all possible contractual arrangements; there still remain possibilities of managerial innovation.

The major alternative explanation is that the individual farmer might view the risk associated with this contract as greater than with the conventional contract. If all farmers have identical but correlated distributions then, if there are a large number of farmers, the risk borne by the individual farmer in the above contract is, if there are \( n \) other firms,
Sharecropping and imperfect information

\[ F^2 \left\{ \sigma_\theta^2 \left( \frac{1 - (1 - \alpha)^2}{n} \right) - 2 (1 - \alpha) \text{cov}(\theta_j, \theta_i) \left( 1 - \frac{(1 - \alpha)(n-1)}{2n} \right) \right\} \]

\[ \to F^2 \left\{ \sigma_\theta^2 - (1 - \alpha^2) \text{cov}(\theta_i, \theta_j) \right\} \]

as \( n \to \infty \)

where \( \text{cov}(\theta_i, \theta_j) \) is the covariance between \( \theta_i \) and \( \theta_j \). Thus, if the \( \theta \)'s are not perfectly correlated, the risk borne by the farmer may be increased. Still, at the margin, one would have thought there would have been a tradeoff: the rental should depend in part on others' output. The incentive gain would at least, initially, outweigh the loss from bearing additional risk.

There is another source of risk which the farmer has to bear. If he does not know his own ability or his own industriousness relative to others, then making his rent (and hence his net receipts) a function of their output creates a new source of risk. For instance, if there were no "weather" uncertainty, the conventional sharecropping agreement would have no risk associated with it, while this proposal might have considerable risk associated with it. This, of course, is more of an argument against the introduction of such a risk-sharing scheme, since once it were introduced, individuals would find out about their relative ability.

6. REMARKS ON WELFARE IMPLICATIONS

Sharecropping has long been attacked as an inefficient traditional method of land tenure; because individuals receive less than their marginal product, it provides insufficient incentives for work. The counter argument that the amount of work can be specified in the contract, and hence there is no inefficiency in sharecropping tenancy, can be understood as a reaction against this traditional view.

Neither view, in our judgment, is correct. The reasons for the introduction of sharecropping — incomplete risk markets, and imperfect information — are ignored by both sides of this argument. In general, with incomplete risk markets and imperfect information, competitive market allocations will not be Pareto optimal. For instance, when there is more than one crop, changing the relative proportion of land invested in different crops affects the price distribution; this effect is ignored by competitive producers, but were the government making the allocation, it would not be (Stiglitz, 1977).

In economies with imperfect information, individuals do not in general receive their marginal products; private returns to the acquisition of information usually differ from social returns. As a result, once again, market allocations will not be Pareto optimal.
Thus, the presumption that the market allocation is efficient seems, at best, weak. On the other hand, there is no presumption that any simple reform, e.g., the abolition of sharecropping, would improve resource allocation. For sharecropping is serving a real economic function; if sharecropping is abolished, those functions may be served in some other but not necessarily preferable way. Any such land reform is then a delicate exercise in the economics of the second best.

7. CONCLUDING REMARKS

What conclusions do we reach from this analysis? First, none of the explanations, by themselves, seems capable of explaining all the stylized facts. This suggests that, in different places and at different times, sharecropping has served a variety of economic functions. Secondly, although it is undoubtedly the case that risk sharing is an important aspect both of the explanation of the prevalence of sharecropping and the determination of the terms of the contract, the simple risk sharing argument with complete observability of labor, as put forward, for instance, by Cheung, seems inconsistent with virtually all of these stylized facts.

Most of our arguments have centered on the importance of providing the tenant with incentives to farm efficiently, and of offering contracts which attract the more efficient potential tenants. Uncertainty plays an important role, for it both makes it difficult for the landlord to distinguish between the tenant's contribution and the effects of the unpredictable environment, and makes it costly to reward the tenant with his full, and therefore fully risky, marginal product. Thirdly, we have used a style of analysis which we believe is widely applicable for the understanding of the institutional characteristics of economies in which market failure is important, and as such, we believe that we have in part provided an analytical reconciliation between the neoclassical and Marxist approach to such problems. Our approach is to ask, in what kind of contracts do agents have adequate information to offer and monitor, and of this set of feasible contracts, which will be chosen by tenants or workers. It therefore makes explicit what all too often remains murky in the Marxist approach, where "it is argued that it is the mode of production, or particularly the way in which the existing social relations of production condition the development of productive forces, that determines the extent both of growth and of equity and inequity within the agricultural sector." (Paine, 1977, p. 336).

Finally, we have argued that tenural reform is not the straightforward exercise of replacing outdated and precapitalist sharecropping contracts with simple rental contracts. The market failures which give rise to such institutions preclude any simple welfare analysis. Even the attractive option of giving "land to the tillers," and thus obviating the need for contracts whose efficiency
is greatly modified by the presence of uncertainty and imperfect information, may have profound effects on the distribution of income, particularly in the access to credit and employment by landless laborers.

Appendix

From equation (17)

\[ dU = 0 = \frac{\partial U}{\partial e} \ de + \frac{\partial U}{\partial Y} \ \{ \frac{\partial Y}{\partial x} \ dx + \frac{\partial Y}{\partial \alpha} \ d\alpha \} \]

Since \( \frac{\partial U}{\partial e} = 0 \) (e maximizes U)

\[ \frac{dx}{d\alpha} = \frac{xf}{\alpha (f - zf')} \]

The first order conditions are

\[ \frac{\partial U}{\partial e} = \alpha E u' \ (Y_w) \ \theta f' (e x) - v'(e) = 0 \]

which, differentiating totally, gives

\[ \left[ (f' + \frac{exf''}{f - zf'}) E u' \theta + \alpha f' E \theta^2 u'' \left( \frac{f'}{x} + \frac{xf}{f' - zf'} \ \frac{(f' - f)}{x^2} \right) \right] d\alpha - \frac{\partial^2 U}{\partial e^2} \ de = 0 \]

\[ \frac{de}{d\alpha} \bigg| \theta = \left( 1 \ - \ \frac{\sigma}{\theta} \right) f'(e) \ E \left[ u'' \ (\theta \alpha f')^2 + u \alpha \ f'' \right] - v'' \]

where \( \sigma \) is given by

\[ \sigma = \frac{f' (f - zf')}{zff''} \]

the elasticity of substitution between effective labor, eL, and land.
Chapter 18

Agricultural risk, rural credit, and the inefficiency of inequality*

Michael Lipton

1. CREDIT AND RISK IN POOR RURAL AREAS

Small farmers are poor enough even “on average.” They are, moreover, subjected to severe risk of downward fluctuations in output and income, superimposed on normal seasonal variations. Credit provides the capacity to borrow in bad times and repay in good times, and this is the normal way to handle such problems. Credit, however, also finances much current input and investment, especially for small entrepreneurs with few savings. In poor countries, moreover, rural credit is highly localized, so that the lender finds his risks tend to go sour together after bad harvests.

This paper argues that these linked problems — local covariance of activities, and the dual consumer-producer nature of credit — restrict, to socially suboptimal levels, the supply of and demand for credit for risky activities by small farmers. Fairly drastic restructuring, between city and country as well as within agriculture, and extending well beyond credit markets, is required to put this right. Without such restructuring, much too little credit will continue to reach the potential paying and repaying activities of small farm borrowers.

Section 2 summarizes the “new consensus” that rural credit operates efficiently, and criticizes some of its implications under conditions of risk. In Section 3, several types of aversion from predicted and unpredicted fluctuation are distinguished, and their implications for the credit market analyzed.

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Section 4 considers the types of fluctuations in yield faced by rural borrowers and lenders on their total business portfolios, and more generally as business households, and the impact on their readiness to borrow and lend for new options. Section 5 summarizes the implications for State action.

2. THE NEW CONSENSUS

2.1. Summary

Scarcity of credit "may not at present be an important constraint on increasing production using traditional methods." This is suggested by AID's 20-volume survey (U.S.A.I.D., 1973, p. 7) and by African (Tison, 1960) and Latin American (Adams, 1971) materials. Farmers can often finance investment from their (surprisingly high) personal savings (Bottrall, 1974), or by reducing ceremonial outlays (Gapud, 1975; Moore, 1953-54). Moreover, highly profitable innovations, as in the case of improved wheat varieties in the Punjab, have steam-rollered through alleged credit constraints.

Nor is rural credit controlled by exploitative moneylenders. Indian data suggest little monopoly (Ghatak, 1975; Long, 1968). Residues are due to remediable, nonstructural causes: urban lenders who neglect rural prospects (Bottomley and Nudds, 1969); rural lenders who concentrate on subsets of borrowers (Long, 1968); and farmers who lack information about lenders (Bottomley, 1964a). High rural interest rates reflect, not monopoly, but the following facts:

(a) There are many small loans and borrowers, raising the lender's cost curve relating average cost per $ loaned to total sum loaned (Bottomley, 1963);

(b) There are many lenders, so each operates above the minimum of his cost curve (Bottomley and Nudds, 1969);

(c) Lending has high opportunity-cost (Bottomley, 1973; contrast Oluwasanmi and Aalo, 1965, p. 73);

(d) Default rates are high (Bottomley, 1973; Ghatak, 1975; Usher, 1967).

Therefore, there is seldom a case for subsidized loans, either to drive down allegedly "monopolistic" rural interest rates, or to raise the supply of credit. Such subsidies — given high rates of inflation, of default, and of administrative costs — mean loss-making institutions; these provide dwindling amounts of credit (Gonzalez-Vega, 1975) and waste scarce public savings by

Outside the consensus, the Marxist literature (notably Hilferding, 1955) offers disappointingly little analysis of rural finance. Outstanding exceptions are (Kautsky, 1899, pp. 300-20) on rural-urban capital transfer, and (Bhaduri, 1973) on interlocked rural market structures.
lending at negative real rates of interest (Erven and Rask, 1971). Already, rural credit is kept cheap enough by loans from relatives, and by existing subsidized credit — which goes mainly to big farmers (Khan, 1963; Long, 1968; Stitzlein, 1967). Institutional rates should, in general, go up (Abbott, 1974; Bottrall, 1974).

2.2. Critique

The new credit consensus is one of the “family” of claims that, contrary to populist rhetoric, equilibrating forces operate in underdeveloped rural areas. Other members of the “family” claim that grain traders do not make superprofits (Lele, 1968); that sharecropping is efficient (Cheung, 1969; but see Bardhan and Srinivasan, 1971; Bell, forthcoming); that, following Hoselitz’s analysis, the rural poor tend to migrate townwards until real urban-rural income gaps disappear (Lipton, 1977, pp. 101-2); and that farmers maximize profits (Hopper, 1965; Schultz, 1964; but see Lipton, 1968). The “family” rightly refuses to blame rural ills on wickedness, stupidity, or undefined market failure. However, in a world of high risk and great inequality, the “family” has major defects.

First, the consensus (like the “family”) tends to infer from extremes to typical cases. In a long stagnating agriculture, where farmers have had generations to learn what maximizes profit (Schultz, 1964) or ensures survival (Lipton, 1968), they have little motive or opportunity for change; thus, they are unlikely to face a credit constraint upon it. Nor is this likely at the other extreme, where innovations offer returns far above prevailing interest rates and reduce objective risk (Roumasset, 1976) to innovating borrowers and their creditors alike. More typical farming situations, however, offer rather risky innovations at moderate, marginally attractive expected returns; say 20 per cent, with a 12 per cent coefficient of variation. Evidence from the extremes does not show that, say, more credit at 10 per cent would fail to stimulate innovation here, though there might well be more efficient ways of doing so.

Second, the consensus as regards rural interest rates (like the “family” as regards prices charged to farmers in general) is rather dissonant. They are sometimes claimed to be high for purely market reasons; sometimes, to be low given the costs and risks; and sometimes, to be above market levels, but desirably so, given the scarcity of savings. A Popperian might ask what observation upon rural interest rates could disturb the consensus that they are not undesirably high. The contradiction arises partly because of genuine regional variations and partly because some analysts, but not other, neglect underestimations of informal interest rates in “quick and dirty” rural surveys. But it raises the central issue of this chapter. Suppose that the average rural interest rate in an area is economically optimal. Beneath this average, are some agents borrowing and/or lending “too cheaply” and others “too expensively?”

1 Yet the consensus also stresses — and rightly (Lipton, 1968, pp. 246-7) — the high rates of farm savings, which are claimed to reduce the need for outside finance.
In particular, do rural credit markets, under conditions of “risk,” so operate that the share of poor farmers in both the supply of and the demand for finance is inefficiently small? The word “inefficiently” is carefully chosen. Leaving income distribution aside for a moment, the aim of policy regarding investment and credit is presumably to steer them towards agents and activities with relatively high net social returns. Such a policy is plainly inefficient if some farmers find it easier to obtain finance than others, equally qualified to invest and equally likely to repay, for projects of equal “risk” and expected return. Inefficiency also prevails if projects facing high “risk,” but also high expected returns, are especially likely to founder because of inadequate supply of, or demand for, credit. Finally, inefficiency is compounded if — as we shall show — the deprived small farmers are more cost-effective investors, and better users and repayers of credit, than the over-endowed large farmers.

3. RISK, CREDIT, SIZE AND DIVERSITY

3.1. Some Conceptual Issues

Before reverting to these issues, I must deal with an underlying question, linking this paper to the theme of the conference. In what sense, if any, does “risk” or “risk aversion” seriously reduce poor farmers’ welfare, or their prospects of raising it? And in what sense, if any, is rural credit relevant? In short, are poor farmers specially handicapped by “risk” or by “risk aversion” from demanding or obtaining finance for “risky” ventures with high returns? For any economic agent — notably a small farmer or his creditor in a poor country — I argue that:

(a) “Fluctuation aversion” always reduces net returns, and can be caused by several objective or subjective considerations, some unconnected with “risk.”

(b) “Risk aversion” covers several distinct attitudes, with different effects, though all are special cases of fluctuation aversion.

(c) It is, therefore, misleading to classify behavior as “risk-averse” simply because measurements on economic and/or attitudinal observations satisfy a particular mathematical requirement; to do so always conflates vital distinctions under (b), and may well include non-risk elements from (a).

(d) This error is especially damaging to our understanding of the potential role, and actual limits, of rural credit in encouraging small, risk-prone family farmers in poor countries to handle risk (and other sources of fluctuation) in ways that increase their returns.
3.2. Fluctuation Aversion

Suppose the social aim is to maximize net product. The nation's portfolio of productive activities should then be so structured, owned, and managed as to reduce diversions caused by other aims and constraints. The wishes of some individuals to avoid, or to obtain, fluctuations in their income create such diversions.

Many forms of fluctuation aversion have nothing to do with risk; they would persist even given perfect forecasting. However, like risk aversion, they deter decision takers from using scarce resources to obtain high but fluctuating returns. Consider two portfolios costing the same but differing in just one activity. The steady portfolio, \( S \), yields \( Q \) at the end of every period; say, at each harvest. The fluctuating portfolio, \( F \), yields \( Q + K \) half the time, \( Q - J \) otherwise; and \( K > J > 0 \). Why might an agent, such as a small farmer or lender in an Asian or African village, prefer \( S \)?

(a) Suppose \( K, J \) and \( Q \) are measured in kilograms of grain — reasonable for a farmer whose inputs are almost all family labor of low opportunity-cost or a lender who borrows and is repaid grain — and that between harvests the agent eats all, and only, the returns from his portfolio. Then, first, the gain in utility (or indeed health) from \( K \) in good harvests may well fall short of the loss from \( J \) in bad ones. Second, given \( Q \), even if \( (K - J) \) sufficed to overcome diminishing marginal utility, proportionate storage losses between harvests would reduce \( (K - J) \) to, say \( (1 - r)(K - J) \), which might not suffice. Third, storage losses are likely to tell against \( F \) even more than this; a bigger proportion of \( (Q + K) \) than of \( Q \) and of \( Q \) than of \( (Q - J) \), will be destroyed, since profit-maximizing construction of “good” storage would presumably not aim to shelter total peak level outputs.

(b) Now allow grain sales and purchases. If \( F \) is chosen, \( (Q + K) \) tends to happen when the region’s whole harvest, too, is high and grain is therefore cheap; and \( (Q - J) \), when harvests are small and grain is costly. Unless

\[
\frac{Q + K}{Q - J}
\]

is implausibly large relative to the absolute price elasticity of demand for grain (Lipton, 1970), \( F \) means less (and incidentally more stable) cash income than \( S \) over the years, unless \( K \) greatly exceeds \( J \).

(c) Now measure \( Q, K \) and \( J \) as net cash returns, assuming perfect markets. Trading costs (transport, plus normal profit on traders’ capital) create a gap between buying and selling prices. Many farmers and lenders need to buy and sell little if they choose \( S \); but if they choose \( F \), they must buy a lot of grain in bad harvests, and sell somewhat less in good harvests. Trading costs can render \( S \) preferable, especially in remote villages, to a straight profit-maximizer.
(d) Now consider the capital market. If $F$ is chosen, the agent could well be a small net lender after good harvests, and a small net borrower after bad harvests. But operating costs mean that he pays higher interest as a borrower than he receives as a lender. Hence, again, a substantial margin between $K$ and $J$ needs to prevail, even if a risk-neutral agent is to choose $F$.

(e) Imperfect markets, especially if larger transactions by an agent worsen his terms of trade, strengthen (b), (c) and (d), and raise the margin $(K - J)$ needed to induce the choice of $F$.

(f) The interaction of (b) and (d) raises this margin further. After a bad harvest, the demand for loans rises, and so therefore does the rate of interest. By adopting $F$, the agent commits himself to borrow more, or lend less, when interest charges are higher.

3.3. Risk and Fluctuation

All these forms of fluctuation aversion can exist without risk aversion, even with perfect foreknowledge of the periods in which $F$ yields $Q - J$. Observations on behavior are likely to assimilate (a) - (f) to risk aversion, and hence to overestimate it. Only (a) unequivocally implies diminishing marginal utility of (project) income, but (d), (e) and (f) imply something close to it: that extra income can do less, by way of earning future increments. To define risk aversion as existing if, and only if, diminishing marginal utility of income prevails (Arrow, 1971a, pp. 93-4; Balch and Wu, 1974, pp. 6, 32) is also misleading for other reasons. The following special cases of fluctuation aversion, between them, cover the different phenomena normally termed risk aversion — dislike of:

(g) Thinking about, or deciding on, one of several uncertain prospects;

(h) The act of gambling or risk taking;

(i) The state of mind (uncertainty) between a risky decision and the outcome;

(j) Regret, at penury induced by unfortunate outcomes, exceeding the dislike of regret at missing large, but ex ante unlikely, "gambler’s luck;"

(k) Risk of disaster, specified in various possible ways (Roumasset, 1976, p. 42); and

(l) The expected utility of the entire probability-income profile associated with $F$, as compared with $S$.

Risk aversion is a psychological disposition to avoid fair bets. Fluctuation aversion is a psychological disposition to avoid unsteady outcomes.
Diminishing marginal utility of income is necessary and sufficient for some sorts of risk aversion, notably (1), but is unlinked to others. A properly-functioning credit market can reduce the extent to which risk aversion, and some other sorts of fluctuation aversion, prevent profit maximization.

To understand “properly-functioning,” one needs to ask what factors, security against which an agent might want to buy, tend to increase his fluctuation aversion. Apart from the familiar factors, some that operate in poor farming communities tend to reduce the demand for, as well as the supply of, credit for $F$-type options. Such factors include a family history of failure in handling risk; a high level of background risk, necessitating care about the maintenance of a credit “reserve” (Barry and Baker, 1971); and isolation from market or other opportunities to shift risk. (Note that all these produce aversion even from fluctuations predicted with certainty; for there is no way of knowing whether nonpredicted risks outside the portfolio will coincide with $(Q - J)$-periods or $(Q + K)$-periods, and risk premium is an increasing function of risk (Kalecki, 1939). In other words, if fluctuation is between $(Q - J = H)$ and $(Q + K = L)$, and the timing of $H$ or $L$ is unknown, then the whole fluctuation is a form of risk even if $J$ and $K$ are predictable.)

The operation of such factors, however, is best treated by looking separately at the plans, portfolios and problems of the small farmer, the lender, and the State. To revert to the central question at the close of Section 2: beneath the surface of static efficiency, does the conjunction of credit and risk in less developed agriculture systems mal-distribute the capacity for efficient growth?

4. THE AGENTS AND THEIR PORTFOLIOS

4.1. Three Types of Risk “Inefficiency”

Construct a “Markovitz frontier” (Markovitz, 1959, pp. 19-26), joining all the possible portfolios that are Pareto-risk-optimal, i.e., that the agent cannot vary without either lowering expected net income, or raising risk on whichever measure you, the reader, prefer: e.g., variance\(^3\) or semivariance of profit; risk of disaster, in one of several possible formulations (Roumasset, 1976). Net returns are maximized if operators in each period are at $Q$, or as near horizontally to it as can be ensured by an efficient credit and insurance market that guarantees the firm’s survival or continued operation even though bad periods.\(^4\)

\(^3\)For objections to the variance measure, see (Rose, 1966, pp. 164-6) and (Roumasset, 1976).

\(^4\)If there are no such markets, nor efficient alternatives, profit-maximizing formulations do not work.
Social inefficiency can be caused if an operator:

(1) Locates (or has creditors who locate) his QM subjectively northwest of where it actually lies (perhaps, by overestimating the disaster risk or downside variance of an improved variety);

(2) Operates further southwest on QM than is needed to ensure survival, because of failures of the credit market, or for want of (State?) insurance that, even if privately unprofitable, makes adequate social returns given the impact on output of encouraging farmers to shift northeastwards;

(3) Fails to take private, or to enjoy public, optimal measures to shift QM southeast over time. (If we interpret the portfolios along QM as mixtures of food crops consumed by the farm family, then we can interpret this as a suboptimal size or allocation of investment funds by, or for, the farmer.)

How might these three types of social inefficiency in handling risk — hereafter types 1, 2 and 3 — be caused by the size, interpersonal distribution or composition of the portfolios of farmers, of their creditors, or of “the State” as it affects them both?

4.2. Farmers, Especially Small-Farm Borrowers

Evidence, still fragmentary but increasing, suggests that small farmers, as compared with big ones:

(a) Use credit more cost-effectively, given the technology (Dorner, 1972, pp. 120-26; Rao, 1970, 1973; Thirsk, 1974; Wills, 1972) — presumably because they get less per acre, and saturate it with more labor and supervision;

(b) Are more likely to find that presence (or absence) of credit determines adoption (or rejection) of an improved technology (Agarwal and
Kumawat, 1974; Schlueter, 1974), presumably because they have fewer other sources of funds;

(c) Show, at worst, no greater ratios of defaults to sums loaned, such ratios depending less on size than on area or the weather (Bouman, 1974; Heyer, 1976; Von Pischke, 1974), and usually smaller ratios where big farmers have the political strength to get away with default (Ames, 1974; Dadhich, 1971; Desai, 1976; Khan, 1971; Lele, 1974, pp. 453, 585-86);

(d) Nevertheless, get much less institutional lending per acre, even when it is expressly intended for small farms (ACCFA, 1956; Adams, et al., 1966; Khan, 1963; Montero, 1968; Ramakrishna, 1974; Rask and Reichert, 1972; Roth, 1968; Sansom, 1970; Shahjahan, 1968), and — at least in Asia and Latin America — less informal credit for production.

This paradox is partly due to the nature of the supply of farm credit, partly to sheer power, and partly to misconceived development strategies (e.g., ADB, 1969). However, as the above formulation suggests, the main problem is on the demand side. What restrains the demand, among small farmers in poor countries, for profitable uses of producer credit?

4.2.1. Information and type 1 inefficiency

Small farmers sometimes choose, and support with highly restricted demands for credit (Ladman, 1971), portfolios northwest of $Q_M$. This is largely because they have little information on how to make modern risk reducing or output-raising research relevant to their needs.

First, their pool of information is small because they are badly placed to generate economic or political demands for relevant research (Evenson and Kislev, 1975, Chs. 3-4; Hayami and Ruttan, 1971), being unlikely to produce for the cities (Lipton, 1977) or for export (Mann, 1968). Moreover, governments concentrate research on crops and areas with safe irrigation or drainage; small farmers lack cash to buy these privately and power to get them publicly. Meanwhile, the bigger farmer who is better off, less prone to risk, and less averse from it, is almost always the initial innovator. Hence, governments “back success” by generating more information for him (Lipton, 1977), even though, as we have seen, he makes less successful long-run use of it. To get southeast to $Q_M$, small farmers prospect in areas far less densely packed with nuggets of information than, in his similar search, does the larger farmer.

Second, small farmers face barriers to the spread of information. They can seldom read, buy radios, or travel to distant model farms. More basically, they are often small because of family histories of failure — bad luck, bad management or exploitation — in handling information, credit and risk. With
such experience, a farmer may well classify himself as unlikely to deal with new ideas well, and may form a psychic barrier against them. Such a barrier perpetuates his distinct, complex and stable method of farming, his “survival algorithm” (Lipton, 1968). This is robust against misfortune, but also against innovations that do not promise lower risk as well as higher net income. Risk aversion becomes information aversion; near the “bankruptcy endpoint (where) the supply of credit vanishes,” poor farmers become “perceptively bound to the local circumstances, following ’middle-of-the-road’ policies that remain stable over time” (Balch and Wu, 1974, p. 7) — and which depend on the inductive beliefs generated by the specific, probably unsuccessful, localized history of each poor farm.

Third, the channels of knowledge are biased away from small farms. Extension workers, being underpaid, often depend on local “big men” and function almost as their private research officers (as do some agricultural colleges). Overstretched extension systems prefer to deliver knowledge to one 100-acre unit rather than fifty 2-acre units; the latter policy — although certainly costing more — might yield greater net social returns.

4.2.2. Type 2 inefficiency and consumer credit

In areas with little technical change and widely fluctuating output (typically, areas of unsure water supply), small farmers do not demand extra producer credit, but operate near $M$ on $Q_M$ (Schluter, 1974), using variance to measure risk. The Scandizzo-Dillon paper in this volume suggests a discontinuous increase, around subsistence level, in the tendency to operate near $M$. This is, statically, privately efficient; but it reveals a degree of risk aversion that greatly reduces social product.

To uncover the main reason why poor farmers operate near $M$, we must look “behind the diagram,” which, like most risk-profit analysis, is restricted to investment decisions. A poor farmer borrows mainly to support consumption in bad years or in the slack season, repaying in good years or at postharvest. Even in the USA, he restrains his productive loans, so as to be able, in bad times, to convince creditors that he is not “over-borrowed” (Barry and Baker, 1971).

In poor countries, costly and informal consumer credit often deters family farmers from operating near $Q$. Unlike big farmers or employees, they almost always find their trouble, as consumers and as producers at the same time, after a bad harvest; if overextended, by loans or risks to get near $Q$, they risk

5 The often-quoted cases of small farmers’ receptiveness to innovations meet these criteria, both in the Philippines (Roumasset, 1976, pp. 172-5) and in the Punjab.

6 This should not be taken to imply that credit subsidies — rather than policies that specifically render risky ventures more profitable, or safer, for poor farmers — are the best remedy (Heyer, 1976).
Credit and the inefficiency of inequality

defaulting on producer credit just when they most need to appear most
creditworthy to those who might lend for consumption. Moreover, they have
better uses than production support for borrowed cash. Such cash is fungible;
an institutional loan at 12 per cent is better and less riskily used to repay (or to
avoid) moneylender consumption loans at 40 per cent than to buy fertilizers
offering 20 per cent.

This does not mean that agencies should tie loans to production.
Fungibility renders this hopeless. A loan, tied to fertilizer purchase, can
honestly be taken up by a farmer who would have bought them even without
it — but who, with it, spends more on his daughter’s wedding. Loans in kind
can be sold. Anyway, why should the agency know better than the farmer
how he should use his credit? The conclusion, rather, is that credit is a total
problem, and that only when formal and informal sources together, and
competitively, meet consumer credit needs will small farmers readily demand
and apply producer credit. Aversion to output fluctuations, and hence to
operation near $M$, can be reduced by measures not directly linked to credit, but
tending to lower the volume, and fluctuations, in demand for consumer loans
to buy food. Such measures could include rises in the shares of public
investment or energy that go towards land redistribution, towards reliable
water control, or towards research into robust low-value crops such as millet.

Indeed, many of the long-run concomitants of general development —
falling agricultural risk, rising income (Arrow, 1971a, pp. 96–8),
“welfare cushions” — tend to reduce both absolute risk aversion and the
demand for consumer credit, and, therefore, the propensity of poor farmers to
operate near $M$. Even given underdevelopment, much can be done, as
sketched above. But a warning against two tempting approaches is needed.
First, price stabilization, whatever its other merits, normally increases the
variability of incomes (and hence of capacity to meet interest commitments) of
small farmer-borrowers (Lipton, 1970). Second, given a poor farm family’s
income and assets, extension agents should not try to talk the farmer to
operate at $Q$. Success is unlikely, since poverty and conservatism probably
both stem from a family history of misidentifying, being unlucky with, or
mismanaging $Q$-type portfolios. If overpersuasion does succeed, but the $Q$-
type portfolio meets a couple of bad years, extension stands discredited.

7 Hypothesis: fluctuation aversion of all types varies little as between, say, a 100-acre and a
1000-acre farmer, but declines greatly as farm size rises around subsistence — from, say, 1 to 5
acres (cf. Scandizzo and Dillon in this volume). Hence, land redistribution from 1000-acre farmers
to 1-acre farmers helps move the farm sector’s total portfolio towards $Q$.

8 Roumasset (1976) has shown that some very poor, very risk prone farmers in the Philippines
are particularly likely to “go for broke” with innovations, because they have, in effect, nothing to
lose. However, the innovations in question, in fact, did not increase risk.

9 Moreover, behavior is not “irrational” just because you, I, or an extension officer fails to
understand it. “Event matching” seems odd, but it reflects minimax regret (Rapoport, et al., 1965;
Samuelson, 1967).
4.2.3. Background risk

In considering whether an agent will seek, apply or get credit for a new activity that will move him towards $Q$, one may look at the following, in increasing order of not only predictive completeness but also research cost:

(a) The risk and profitability of the activity being considered by him;

(b) The impact on, and the nature of, his total “productive” portfolio (Markowitz, 1959);

(c) The impact on, and the nature of, his production and consumption activities (Section 4.2.2);

(d) The impact on the risk-returns structure imposed on him by all the contingencies he faces (this section);

(e) The impact on his total net worth (best seen in the context of Type 3 inefficiency; see Section 4.2.4.).

Poor people in poor rural areas face exceptionally high background risk — an unfavorable “initial prospect” deterring new “ventures” of high marginal risk (Hildreth, 1974), unless such activities tend to do well when their other activities do badly. Background risk extends beyond production (pests, drought or flood, price collapse, etc.), and even beyond sudden needs for consumer credit. It covers the risk of diseases, which are usually frequent, unpredictable, uninsurable and costly to treat; the risk of a pregnancy, withdrawing labor and requiring extra food and subsequently extra outlays on education; and many other risks, from fire through theft to a migrant relative who stops remitting money.

Minimal social insurance against some of these background risks, especially if traditional forms of protection, such as the extended family, are weakening, may be a more cost-effective way of encouraging poor farmers to “climb” $MQ$ than either credit subsidies or direct attempts to reduce agricultural risk. The exceptionally fast spread of high yielding rice varieties in Sri Lanka may be related to its — for a poor country unusual, and much criticized — system of social welfare.

Protection against background risk is especially important because small farmers in an isolated community, producing much of their output for family farm consumption, probably lack methods to shift\textsuperscript{10} or to share the cost of fluctuations in conventional production. Most market transactions — in goods, factors, or credit — create possibilities for risk shifting, and normally both parties gain when the more risk-averse pays the less risk-averse to take on some of his risks; few, separate, imperfect markets in many poor rural areas

\textsuperscript{10}Economies conspicuously lacks theoretical or empirical work on “risk shifting.” The analysis of risk, in marked contrast to tax analysis, seems to assume that impact falls where incidence falls.
make this harder. The sharing of costs from fluctuations is impeded by the lack of equity content in most lenders' portfolios (Section 4.3).

4.2.4. Against type 3 inefficiency: diversify what?

Diversification can, of course, be seen as an issue of which portfolio, or linear combination of two portfolios, on MQ to choose. Linear combinations are at least as diversified as the component pure portfolios, and both M and Q are pure portfolios, but no other general statement can be made about the relationship of diversification to nearness to Q or M, nor therefore about its impact on Type 2 inefficiency.

In any case, the effect of diversification on Type 3 inefficiency is more important and interesting. Improvements, especially for larger farmers, are achieved less by moves on a static QM than by investments that shift QM southeastwards, through acquiring new productive assets (a tubewell, a field of high yielding rice) that other farmers cannot yet include in their portfolios. Type 3 inefficiency is caused, then, mainly by barriers (including credit constraints) to such diversifying investments. As it is cured and MQ pushed out, the farmer — for whom downside risk no longer means disaster — is likely, anyway, to move from M towards Q on each given frontier.

However, it is hard for small farmers to diversify their farming. As compared with, say, 400 acres, it is less attractive to try a new cropping pattern on 25 per cent of two acres, especially if holdings are fragmented. Soil or water specificities are likelier to create problems, and there are lost scale economies.\(^{11}\) Extreme diversification of minifarms seldom makes sense anyway, as the assumptions on which it is risk-reducing (Samuelson, 1967; Hadar and Russell, 1974, p. 147; Hamada, 1974, p. 151) fail: crop outputs in an unirrigated smallholding have positive, not zero, covariance; and their probability distributions are usually skewed, not normal. Therefore, not all crop or technique diversification reduces risk.\(^{12}\) However, to overcome restraints on the small farmer's capacity, to diversify is to enlarge his options. New options can push out his MQ. That reduces both his fluctuation aversion and his unattractiveness to creditors.

So it is desirable to diversify small farmers' asset, but hard to do so on their farms. Can we again look "behind the diagram," this time to see if a given (low) degree of farming diversity can provide more security — and raise the demand for credit in support of Q-activities — if a farmer diversifies off-farm components of his total net worth?

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\(^{11}\) Not of the conventional type (Schultz, 1964), but specific to innovative diversification. To gather information, seed and credit for a new crop can be nearly as costly for 1/2-acre as for 100 acres.

\(^{12}\) Indeed, it often has other aims; mixing beans with maize or millets conserves nitrogen (Norman, 1974).
(a) Nonlocal farm assets are unlikely to attract small farmers, given their information and the state of capital markets.

(b) Financial assets, including even crop insurance policies (given moral hazard, administrative costs, and covariance of crop failures), face similar limitations.

(c) Nonfarm real assets, often in “human capital” are a more promising way to diversify net worth. Many farm families contain bricoleurs — migrants-of-all-trades — and produce substantial nonfarm outputs (Hymer and Resnick, 1969; Levi-Strauss, 1966). Often, a son migrates towards remote sources of income as part of a deliberate diversifying strategy by the family as a whole (Stark, 1975). Discouragement of such diversification (by barriers to migration, capital-intensive rivals to rural crafts, etc.) impedes small farmers from shifting QM outwards.

(d) Household inventories are even better tools for diversifying net worth. Grain stocks are, first, a form of insurance, being worth most when the harvest fails. Second, they diversify “behind the diagram,” since they are likely to be contravariant in value with many other assets: drought-stricken cattle, flooded land, jewelry that is offloaded in hard times. Improved storage structures, at family-farm level, induce farmers to push out QM in another way as well by preserving grain, leaving them with more spare investible surplus.

(e) Negative assets — liabilities — are a neglected and suitable case for diversifying treatment. In most poor countries, small farmers’ liabilities comprise mainly loans from the traditional moneylender. Often, they must borrow from a single patron-landlord, merchant or employer — or risk losing his other services (Bhaduri, 1973). Hence, these liabilities are undiversified in source and type, and their rigor depends on one lender’s needs, alternatives, or whims. Moreover, such liabilities are “anti-equity”: they tend to be largest when the borrowing farmer faces bad times. Most loans are at fixed nominal interest, but are made and repaid in grain. This is worth most after a poor harvest. Then, too, lenders are likeliest to be hard-pressed — and hard-pressing.

The small farmer would be more ready to push out QM, and to operate nearer Q, if he could diversify his sources and types of loan. Moreover — given that his main productive assets (plots planted to different crops) are covariant in yield, but that “a risk averter should prefer... a venture that is negatively

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13 They get few institutional loans, and it is seldom the really poor who can borrow from (wealthy) relatives.

14 This, in a letter, suggests, these issues matter most where there is (a) monoculture, (b) stagnant technology, (c) little irrigation and frequent drought, (d) flat land producing a risk of severe, uniform flooding, (e) an inherently risky (notably a pest-prone) technology.
correlated with his initial prospect" (Hildreth, 1974, p. 100) — he needs negative ventures that are positively correlated with his initial prospect, i.e., equity borrowing, which costs the borrower less when the farming content of that prospect does badly. At present, sharecropping, with its possible disadvantages and its double-bind effect upon capital markets when landlord and moneylender are the same person (Bhaduri, 1973), is almost the only such form of equity.

4.3. The Lender's Portfolios

Sometimes, a network of lenders — Chinese in Malaya, Pakistanis in Malagasy — can create a diversified structure of assets, much as branch banking does in Britain. More usually, creditors are small, none-too-rich, localized and thus with covariant assets, and highly risk-averse. To diversify small farmers' liabilities may diversify lenders' assets too. For instance, if a lender L1 lends $X to borrower B1 and $X to B2, and and L2 does the same, all parties are more diversified than if L1 lends $2X to B1 and L2 lends $2X to B2. However, the linkage is not automatic, and its usefulness to a localized lender is limited by the high covariances among borrowers' crop outturns, and hence their capacities to repay, in a locality. Could specific steps to diversify the lender's assets induce him to push out the supply curve for money-to-lend, especially to small farmers for Q-type activities?

One method would be to persuade him to hold M-type government securities (ACCFA, 1956). That would be costly. It would require high bond-rates, active rural banks, and perhaps inflation-proofing. Also, it would not tackle the central structural weakness of rural lending under risk — its lack of equity content. This could be tackled, and the over-concentration of lenders' financial assets reduced, through an Agricultural Finance Corporation (AFC). Lenders to AFC would get (a) a small fixed-interest return, perhaps inflation-proofed, plus (b) an equity element, normally larger and never negative, varying with crop outturn. Borrowers from AFC would face a similar, somewhat higher, two part tariff. AFC might hire selected local farmers as agents, thus vicariously obtaining decentralized information about borrowers' skills and repayment over a wide area.\(^{17}\)

What of such information for small lenders themselves? It is usually limited — both for relatives\(^{18}\) lending to one or two extended families and for

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\(^{15}\)Analogously, if comparative advantage permits both courses, it is usually more promising, in seeking balance-of-payments stability, to expand (a) imports covariant with the initial export bundle, rather than (b) exports contravariant with it.

\(^{16}\)What about diversifying the lender's liabilities, or making them more stable, or more covariant with his income? Too little is known about them for useful comments. Research, especially on hedging, could well pay off.

\(^{17}\)In correspondence, Bousard describes the operations of France's "credit agricole" in these terms.

\(^{18}\)Their interest is often psychic, ranging from gratitude, through expected reciprocation and "emotional blackmail," to patronage.
commercial village lenders — to a small area. This damages farm borrowing for \(Q\) activities in three ways. First, the lenders' portfolios contain covariant ventures — borrowers succeed together or fail together; that increases his aversion from new local, covariant loans, especially for high-variance \(Q\)-type activities (Hickman, 1974; Hildreth, 1974). Second, if lenders do diversify, it is out of agriculture: towards urban ventures (Kautsky, 1899, pp. 202-12) suggested — or owned — by their migrant relatives, but often \(M\)-type and of low social yield (Lipton, 1977, Ch. 8); or towards nearby rural non-agriculturists, who generally have poor repayment records (Desai, 1976; Von Pischke, 1974). Third, the established lender, through successes and failures, acquires intensely specialized knowledge of local borrowers, so that new, potentially competitive lenders are deterred; they fear to find themselves (a) worse informed than established rivals about clients' repayment prospects, (b) lending, on the whole, to worse prospects because they are unable to identify these, (c) obliged to charge higher interest to all, and hence to deter “good” borrowers,\(^{19}\) and therefore (d) at high risk of bankruptcy. AFC might help by selling private lenders information about areas (not individuals) with high actual or potential repayment capacity.

Lenders who are not themselves farmers, even if well informed about local borrowers, may lack information about local prospects for farm innovation. That increases their subjective assessment of the risk premium required to lend for such projects, including projects (e.g., tubewells) that in fact reduce borrowers’ risk. Extension officers might well raise farm output by diverting some time to telling lenders about new, financeable activities that — if financed — can push out borrowers’ \(QM\) boundaries, and hence their repayment capacity.

Improving literacy and transport are gradually softening lenders' attitudes to \(Q\) activities, by increasing information and reducing subjective risk. Inflation, too — by penalizing cash holdings and subjecting that penalty to uncertain fluctuations\(^{20}\) — induces lenders to get out of cash by extending their portfolio into higher \(Q\) ranges. With cash unpopular, it is a good time for research and extension to stress innovations that raise willingness to lend by making loan assets less illiquid, \(i.e.,\) by reducing the time during which risk is incurred, and hence the speed with which the lender can react to success or failure. Non-cash assets can function as transactions balances (Tobin, 1958, p. 2); more generally, the shorter the loan, the smaller the lender’s sacrifice of liquidity, flexibility, and hence security. The quicker turnover of cash is, therefore, an important “hidden” credit-risk benefit from a shift to double-cropping, or from the adoption of an earlier maturing crop or variety.

\(^{19}\) I am grateful to David Newbery for this comment; Akerlof (1970) supplies a close analogy.

\(^{20}\) Maybe, in 1959, cash holdings had “zero return and zero standard deviation” (Markowitz, 1959, p. 20); that reads optimistically now.
Probably, demand and not supply of credit is the usual constraint on small farmers’ Q-activities. To relax the supply constraint where it does exist, policymakers must increase the volume of lending that supports small farmers. This new lending can support either new Q-activities or other ventures, including consumption borrowing, that are undertaken anyway, and if supported by loans can free cash, raise income, lower background risk, or otherwise increase the borrower’s own supply of fungible resources to finance his Q-activities. In either event, traditional lenders — unless replaced by socialized credit — require appropriate incentives to shift loans to Q-activities and small farmers. Yet counter-incentives prevail in reality. Subsidized institutional loans drive out marginal private lenders, and thus probably reduce the proportion of private credit available for Q-ventures and for poor borrowers. Compulsory reduction of interest rates, without structural reform of credit markets, merely reduces loans made available to poorer clients (Blitz and Long, 1965). So would the easy option of legislation shifting risk, from “those for whom an unhappy realization would have the greatest relative impact” (Arrow, 1971a, p. 20), not as is appropriate onto the State or the collective, but through law that unwise “requires creditors to assume some of the risks of the debtor” (Arrow, 1971a, p. 139).

The status quo is especially unfortunate in its impact on lenders’ willingness to finance small, efficient farmers in Q-activities. A locally powerful lender does have some monopoly power. Yet, the usual advantage of scale economies due to the principle of insurance (Florence, 1972, pp. 60-1), is aborted by the covariance of local loans: when the harvest fails, the repayment prospect of all loans worsens.

If the lender seeks security in big loans to big men, they have power over him. Nationwide rural banks or cooperatives reduce such dangers but incur others: ignorance, drift of funds and rising administrative costs. There is scope for direct State action on risk and credit; but probably more at the borrower’s end, where fluctuations of output and income originate, than at the lender’s.

5. STATE ACTION ON RISK AND CREDIT

Some would argue that, whatever the rhetoric, the State is so much an executive for the beneficiaries from monopolies in rural credit — and from its concentration on rich farmers — as to rule out public action to shift loans to small farmers, even if such a course is “efficient.” There are several refutations of this argument. First, in poor countries, if the State is an executive, it is for the cities — the burghers, not the bourgeoisie — and commonly 10 to 25 per cent of State, bank or institutional loans go to the rural areas where 60 to 80 per cent of people live (Lipton, 1977, pp. 298-9; MacNamara, 1973, p. 20; Newsletter, 1975, p. 4); a shift in price and other biases against agriculture, and an associated rise in its share of public credit, would indeed be a most effective
way to finance $Q$-activities by small farmers. Even if the extra public credit went to big farmers, it would raise the supply and reduce the price of credit for all. Second, this is not a zero-sum game; more output, from more "$Q$-oriented" or small-farm-oriented allocations of credit, would in principle permit the State to distribute some absolute benefit to all social classes; and urban growth is eventually strangled if excessive urban bias inhibits farm finance. Third, the State is nowhere a monolith, and usually includes bureaucrats whose careers partly depend on rural growth or poverty reduction, and hence indirectly on funding $Q$-activities. Fourth, whatever the malversations, most States have, in fact, tried consciously and not totally unsuccessfully to bring some credit to the rural poor.

Assume, then, that "the State" or part of it wishes to enhance both equity and growth by operations, affecting credit, that stimulate $Q$-activities by small farmers without imperilling their continued functioning. There are three alternatives. Direct measures — creating public lending or risk-bearing agencies, enlarging or restructuring them, or altering rules or incentives for private agencies — operate on the demand or supply of credit as such, or on the willingness to undertake or to finance risky ventures as such, especially with respect to small farmers. Indirect measures alter the background of risk or of finance against which farmers or lenders operate. Structural measures reallocate resources towards those who are more inclined towards, better at, or more in need of gains from, $Q$-ventures.

5.1. Direct Measures

General credit subsidies, amounting under inflation to negative interest rates (Feder, 1960; Simonsen, 1967), were long the favorites of aid agencies, but are largely discredited (Adams, 1971). Recurring defaults, as already discussed (Battles, 1960; Evenson and Kislev, 1975; Fernandez, 1968; Hatch, 1974; I.L.O., 1971; Miller, 1970; Motooka, 1975; Oluwasanmi and Alao, 1965), mean that such subsidies leak to the not-so-poor and bankrupt the credit agencies (I.D.B., 1971; I.L.O., 1971).

Specific subsidies for $Q$-activities could aim to raise their profitability or to lower their risk. Almost nothing is known about lenders' or borrowers' responsiveness to, let alone about the cost-effectiveness of, these two alternatives. Both could prove fungible to the point of administrative nightmare.

5.2. Indirect Measures

The above discussions suggest that some negative State action may be more promising. Its credit agencies should not be hampered by restrictions preventing consumption loans, which are often the best way to lower small farmers' background risk. They should not be subjected to restrictions (in
practice not applicable to the private lender) that prevent them from
"competing down" lending rates for small farmers, e.g., to laws against
13-14) as security against credit.

More positively, can the State provide crop insurance for small lenders,
or, as described for Mexico by Gomez at the conference, encourage corporate
banks to do so? At present, rural informal interest rates are high partly because
they include lender's risk premia, to compensate him for uncertainties about
default that are due mainly to harvest fluctuations. Such uncertainties are
greater for loans to small farmers with less access to reliable control of water
and pests, and for loans to farmers with portfolios near Q. Hence, the lack and
cost of credit for small farmers, which explicitly prevents them from
"following" innovations although it seldom prevents big farmers from trying
them initially (Schluter, 1974, p. 15; U.S.A.I.D., 1973), are in part due to the
absence of a source of crop insurance independent of the local lender.
However, Gomez's data and Clive Bell's experiences in North Bihar confirm
that "moral hazard" renders crop insurance very costly to supervise.

"General development," by raising both income and safety, probably
lowers risk aversion. The fact that absolute risk aversion increases with risk,
however, implies that a special premium attaches to State action which lowers
risk. A tubewell, even a rural health center, will raise the farmer's
preparedness to try out an apparently unrelated Q-venture. How much?
Nobody knows. But contingency analysis, in benefit-cost appraisal of any
project, is indicated to allow for its impact on attitudes to Q-ventures.

The role of information, in reducing both risk and risk aversion, has been
outlined above.

5.3. Decisions Among Direct and Indirect Methods

The standard economic approach to the State's choice among actions to
achieve a given end, with limited resources, is benefit/cost analysis (Little and
Mirrlees, 1968). This is supposed to allow for everything that makes private
returns-costs analysis, at current prices, socially "wrong": for externalities,
market imperfections, and in some versions aims other than net output, e.g.,
income distribution (Lall, 1973). In principle, avoidance of fluctuations by the
State could be one such extra aim. Whether it is or not, the effect of reduced
fluctuations upon private decisions, and in particular the stimulus to private Q-
activities provided by public control of pests or droughts, should be part of
benefit/cost calculations, even if they count only extra net output as a benefit.
The trouble is that nobody knows either the exact impact of alternative public
projects on the risks of disaggregated groups of farmers, or even the
approximate effect of changing background risks on their private Q-decisions.
Nevertheless, the small number of affected farmers, per unit of cost, does
almost suffice to rule out some proposals, notably crop insurance. And in areas
of exceptionally dense, mobile rural populations — Java, West Bengal — the costs of further improving credit markets are probably high; initial efficiency is not bad, both because many borrowers can shop around, and because the spatial concentration of loan-financed assets brings down the cost of supplying, maintaining (Palm, 1947), and hence financing such assets.

In our present state of ignorance, “threshold” effects, discontinuously altering responses to the demand or supply of finance for Q-ventures if and only if expected calories are near a threshold requirement. Suppose (i) marketing costs of food, in a particular village, mean that a farm family always eats its own grain produce, relying on cash crops for income to buy non-food; (ii) the family needs 2,000 calories per member per day; (iii) the Q-venture, while substantially raising cash-crop output, also raises the gap, as between a good and a bad year, in daily calorie availability per family member from zero to 500. If the family’s average calorie output and consumption, before the Q-venture, is 2,400 per day, well over the 2,000 threshold, (iii) is not a severe deterrent; at 1,900 per day, it is. Calorie security, increased availability, or investment and research, all with special reference to crops grown and/or eaten by poor farmers, are specially likely to push potential Q-venturers across such a threshold.

When seeking areas of public investment with high, favorable external benefits (from reducing risk and encouraging supply and demand of Q-finance), the State should seek areas where general public provision increases, or at least does not reduce, the benefits to the “early bird,” the Q-innovator who has anticipated it. Water control, or the timely repayment of credit to “save” a local cooperative, are activities from which a farmer benefits most if some degree of cooperation in them is enforced on his neighbors by law, or stimulated by public provision. The innovator who guards his crops against a pest, on the other hand, transfers his risks to others, and gets a better price for his crop if they lose output to the pest he has kept out; that incentive to innovation is reduced, perhaps reversed, by public control of the pest.

Resource allocation among direct and indirect methods of stimulating Q-activities should be guided, finally, by prospects for getting the gains from these methods through to the intended beneficiaries. Consumer credit, high background risk, income so low that one unlucky investment compels the sale of the farm if not worse — these are “Q-deterrents” mainly for small farmers, who appear to be the more efficient users of credit anyway. Equity apart, the reduction of risk for big and irrigated farms, which probably face little of it and are not greatly averse from it, is usually a less efficient procedure than is the concentration of similar risk-reducing outlays on the subsistence producers, if they behave as suggested by Sandizzo-Dillon and Ortiz (Chapters 8 and 13).
5.4. Structural Methods

Fluctuations in returns to existing factors of production have undesirable effects and deter new investment. In face of them, credit is the main way to defer a cash obligation. Hence, it is important that credit be so structured and distributed to alleviate fluctuations effectively.\(^{21}\) In large part, that means getting credit to agriculturists, who are most affected by fluctuations, and hence most in need of a variable cash flow to maintain consumption and to plan investment.

In agriculture, within each year, the pattern of the seasons imposes fluctuations, largely predictable, in output, income and nutrition. To these must be added less predictable year-to-year fluctuations, creating “risk.” Agriculture, too, supports (largely as entrepreneurs but also as laborers) a disproportionately high share of the nation’s poorest, for whom a given downward fluctuation in income matters most, and who are least able to meet it from their own cash reserves (i.e., without borrowing). In agriculture, too, the informal credit markets are less perfect than in other sectors, more fragmented, and (because of local covariance) more affected by lenders’ risk aversion.

Yet agriculture is severely deprived of institutional credit. In India, the ratio of such credit to net value added in 1974-75 was less than one-fifth of the ratio enjoyed by “commodity industry” (mining and quarrying, manufacturing and electricity) (Lipton, 1976). India is less urban biased than most developing countries, whose pricing and investment policies mean that agriculture has typically supported the 70 per cent of populations who depend on it with under 20 per cent of investment (Lipton, 1977). Hence, the new assets that might raise income, reduce fluctuations, and lower risk aversion — as well as the institutional credit that can alleviate the effect of fluctuations — have been concentrated on non-agriculture: the less fluctuation-prone, less risk-averse sector. The most important structural change, to alleviate the risk credit situation in most poor countries, would be a dramatic rise in the power and priority of agriculture.

The most important thing that the State can do about the structure of credit, to stimulate \(Q\)-activities on small farms, is to shift credit towards agriculture as a whole; that involves the whole of policy towards the sector, not just credit policy. Similarly, if the State seeks to increase the share of credit within agriculture that supports \(Q\)-activities and small farms — and hence the return to credit,\(^{22}\) taking good years with bad — much more is involved than policy towards farm credit. The importance of total family-farm lending to

\(^{21}\) Subject to efficiency constraints upon social returns which, however, agriculture more than meets (Lipton, 1977, Ch. 8).

\(^{22}\) Not only statistically, but also because lack of cost of credit often prevents small farmers from “following” innovations that pay both big farmers and society (Schluter, 1974, p. 15; U.S.A.I.D., 1973).
meet fluctuations in availability and price of consumer-goods as well as background risk, has been stressed.

The implications, for agricultural restructuring, of "credit policy" go further than that, however. In particular, they involve land redistribution. Several chapters in this book confirm the view that Q-aversion (a) increases dramatically as holding size falls from say, 6 acres to 4, or 4 to 2, but (b) is unlikely to change much as holding size falls from 500 acres to 498, or 496, or even perhaps 250 or 100. This corresponds to Schluter's finding that small farmers operate near M, and in areas of high water risk, are impeded from innovating (pushing QM outwards) by risk-aversion that lowers their demand for credit (Schluter, 1974). It further provides a strong argument for land redistribution. Especially in "Latin American" situations of extreme inequality, and especially if prolonged uncertainties about future holding sizes and tenure laws can be avoided, such redistribution must dramatically raise the share of demand for credit that is in support of Q-activities. It must also substantially reduce the share of credit that supports, not production, but "the descending spiral of rural debt" (Bailey, 1960): credit supplied (from the surpluses of big farmer-moneylenders) and demanded (by sub-subsistence farmers) for everyday consumption needs.

"Marginalist" policies to improve credit markets, and "radical" policies to redistribute assets, are complements, not substitutes in the attempt to improve welfare and productivity on small farms, as elsewhere (Pigou, 1932). Attempts at institutional middle ways, however, have seldom worked. They are costly, dependent on charismatic leadership, and hard to replicate (Khan, 1972). Also, they rarely reach the poorest farmers. It is these whose Q-aversion is so serious a barrier to efficiency and equity alike.

23Large farmers' greater capacity for Q-activities may partly explain increasing polarization between them and small farmers in income-per-person (Weeks, 1970).
Chapter 19

Optimal price intervention policies when production is risky*

Peter B. R. Hazell and Pascuale L. Scandizzo

The authors have previously argued (Hazell and Scandizzo, 1975) that when agricultural production involves stochastic yields, then reasonable specification of the market structure leads to the result that optimally distorted prices are more efficient for social welfare than competitive market equilibrium prices. This paper provides a brief review of that finding, as well as providing a generalization to the multiproduct case within the framework of agricultural programming models. Results are also presented on the magnitudes of the optimal price distortions and associated welfare gains obtained from a linear programming model of agricultural production at a subsector level in Mexico.

1. OPTIMAL PRICE DISTORTIONS

Consider the following market structure for a single commodity.

\[ S_t = \lambda e_t P_t^* \]  
\[ D_t = a - b P_t \]  
\[ S_t = D_t \]  

*The opinions expressed in this chapter do not reflect those of the World Bank.
and
\[ E(\varepsilon_t) = \mu, \quad V(\varepsilon_t) = \sigma^2, \quad \text{Cov}(\varepsilon_t, P^*_t) = 0 \text{ for all } t, \]

where \( P^*_t \) is the price anticipated by producers at the time of making production decisions, \( \varepsilon_t \) is stochastic yield, and \( a, b, \) and \( \lambda \) are positive constants.

This model has the following key features.

(i) Anticipated price, \( P^*_t \) is the relevant forecast of \( P_t \) made by producers at the time of committing their inputs for period \( t \). Typically, in agricultural production, there will be a lag between such decisions and the realization of production. As such, \( P^*_t \) incorporates anticipations about both actual yield \( \varepsilon_t \) and about total supply \( S_t \). The assumption that \( \text{Cov}(\varepsilon_t, P^*_t) = 0 \) rules out the possibility of perfect forecasts (in which case the model would collapse to a simultaneous specification) and implies no knowledge is available about \( \varepsilon_t \) other than that the parameters \( \mu \) and \( \sigma^2 \) are known.

(ii) The stochastic yield term \( \varepsilon_t \) is multiplicative. This specification is preferred to the more conventional additive\(^1\) model for two reasons. First, because it is the input decisions which are assumed to be price responsive (see (i) above), so that the basic behavioral relationship on the supply side is anticipated supply \( E(S_t | P^*_t) = \lambda \mu P^*_t \). Actual supply in period \( t \) is then \( S_t = \lambda (\mu + r_t)P^*_t \) where \( r_t \) is the yield deviation from the mean in the \( t \)th period, that is, \( \mu + r_t = \varepsilon_t \). Second, the multiplicative specification leads to an increasing rather than a constant variance of total output with increasing input use, that is,
\[ V(S_t) = \lambda^2 P^*_t^2 \sigma^2, \]
and this increases with anticipated price. However, the coefficient of variation is constant and equal to \( \sigma/\mu \).

If the yield term \( \varepsilon_t \) is bounded on some positive interval \( \varepsilon_m < \varepsilon < \varepsilon_M \), then the market structure can be portrayed as in Figure 19.1. The anticipated supply function \( E(S_t | P^*_t) = \lambda \mu P^*_t \) is linear, and passes through the origin. In the diagram, if producers anticipate \( P^*_t = P_t \), then they will plan production for period \( t \) so that the expected market output is \( S^*_t = \lambda \mu P_t \). However, because \( \varepsilon_t \) is stochastic, the actual supply function can rotate in a random way around \( E(S_t | P^*_t) \) to any position contained in the funnel defined by \( S(\varepsilon_m) = \lambda \varepsilon P^*_m \) and \( S(\varepsilon_M) = \lambda \varepsilon P^*_M \). Hence, if expected supply in period \( t \) is \( S^*_t \), actual supply could take on any value on the line \( AB \). Clearly, actual market price is stochastic with \( \varepsilon_t \), and the actual price in period \( t \) may take on any value between \( P_t^m \) and \( P_t^* \).

\(^1\)An additive specification subsumes all the yield stochasticity into an intercept term for supply. Such specification is common in the literature (Massell, 1969; Oi, 1961; Turnovsky, 1974; Waugh, 1974).
Figure 19.1. A market with multiplicative risk

From equation (3), the market must clear, hence the market clearing price each period is

$$P_t = \frac{a}{b} - \frac{\lambda}{b} \varepsilon_t P_t^*.$$  \hspace{1cm} (4)

Since $\varepsilon_t$ is stochastic, then $P_t$ must also be stochastic, so that we shall consider an equilibrium price, if it exists, to be the convergent mean price $\lim E(P_t)$. It is not hard to show that convergence occurs if $\lim E(P_t^*) = \lim E(P_t)$, that is, if farmers on the average settle on the self-fulfilling expectation price (Muth, 1961) as their anticipated price. Under this condition, the market equilibrium price is

$$\lim E(P_t) = \frac{a}{b + \lambda \mu}. \hspace{1cm} (5)$$

2Sufficient and/or necessary conditions can be derived under specific assumptions about $P_t^*$ (Bergendorff, Hazell and Scandizzo, 1974).
Optimal price distortions arise because this equilibrium price does not maximize the social welfare function defined as the sum of the expected values of the producers’ and consumers’ surplus.

The consumers’ surplus in period \( t \) is simply the value of the area under the demand curve and above actual market price \( P_t \). Algebraically,

\[
W_t = \int_{P_t}^{a/b} (a - bP) \, dP.
\]

Solving, taking the expected value and simplifying,

\[
E(W) = \frac{\lambda^2 \mu_2}{2b} \left[ V(P^*) + E(P^*)^2 \right]
\]

where \( \mu_2 \) denotes the second moment of \( \varepsilon \) around zero, and \( V(P^*) \) is the variance of anticipated price.

Producers’ surplus in period \( t \) is a little more tricky, since production costs depend on anticipated price \( P_t^* \), and not on actual price \( P_t \). The surplus, which is really an \textit{ex post} concept in this case, is calculated as

\[
\Pi_t = P_t S_t - \int_0^{S_t^*} S/\lambda \mu \, dS
\]

where \( S_t^* = \lambda \mu P_t^* \) is anticipated supply in period \( t \). \( \Pi_t \) is total realized revenue \((P_tS_t)\) less production costs as measured by the area under the anticipated supply function from 0 to \( S_t^* \). In Figure 19.2, where it is again assumed that \( P_t^* = \rho_t \), and the actual supply is \( S_t \), in this case, the surplus is simply the area \( \text{O}P_tS_tCS_t-\text{O}BS_t \).

Solving, taking the expected value and simplifying, the expected producers’ surplus is,

\[
E(\Pi) = \frac{a}{b} \lambda \mu E(P^*) - \left( \frac{\lambda^2}{b} \mu_2 + \frac{1}{2} \lambda \mu \right) V(P^*) - \left( \frac{\lambda^2}{b} \mu_2 + \frac{1}{2} \lambda \mu \right) E(P^*)^2.
\]  \( (7) \)

Adding (6) and (7) together, the chosen social measure \( E(SW) \) is then expressed as

\[
E(SW) = \frac{a}{b} \lambda \mu E(P^*) - \frac{1}{2} \left( \frac{\lambda^2}{b} \mu_2 + \lambda \mu \right) V(P^*) - \frac{1}{2} \left( \frac{\lambda^2}{b} \mu_2 + \lambda \mu \right) E(P^*)^2.
\]  \( (8) \)

This function has its maximum when
Figure 19.2. Producer's surplus with a negative disturbance term.

\[ E(P^*) = \frac{a \mu}{b \mu + \lambda \mu_2} \]  

and \( V(P^*) = 0 \). That is, when farmers anticipate the price \( P^* = a \mu/(b \mu + \lambda \mu_2) \), in each and every period.

Assuming (9) is satisfied, then substituting this result into the expected value of (4), expected market clearing price becomes

\[ E(P_t) = \frac{a (b \mu + \lambda \sigma^2)}{b (b \mu + \lambda \mu^2)} \]  

(10)

This price is not the market equilibrium price in (5), but rather, it is an optimally distorted price for the market. It can be shown that (10) is greater than (5) while (9) is smaller than (5), so that the optimal distortion is effected when farmers produce less than an equilibrium quantity on average — corresponding to the lower anticipated price obtained in (9) — and hence realize the higher average market price obtained in (10).

The percentage market price distortion \( T \) can be expressed as

\[ T = \frac{R^2 100\%}{| \xi_d | \left( | \xi_d | + R^2 + 1 \right)} \]

\( T = [E(P_t) \lim E(P_t) - 1] 100\% \), where \( E(P_t) \) is obtained from (10) and \( \lim E(P_t) \) from (5).
where $|\xi_d|$ is the absolute value of the elasticity of demand measured at market equilibrium, and $R$ is the coefficient of variation for $\varepsilon$. Clearly, $T$ will never be negative, so that optimal distortions always imply price increases. Further, for fixed $R$, the distortion is seen to be larger the more inelastic the demand, but it disappears at the limit as the demand elasticity is increased towards infinity. The distortion also increases with $R$, so that the more risky the production, the greater the optimal market price distortion. In a deterministic market, $R = 0$ and the optimal distortion is 0.

The existence of an optimal distortion price requires some explanation. Basically, it can be attributed to two factors in the model specification. First, because production costs are dependent on anticipated price $P'$ and not on actual market price $P$. This means that there is no fixed relationship between revenue and costs, and that for some $P'$, the yield $\varepsilon$, outcome may, in conjunction with the inelasticity of demand, conspire to cause revenue to fall below costs to the extent that there is a net welfare loss to society. In itself, this cost is not sufficient to distort the market. However, because of a second feature of the model, the multiplicative risk term, the variance of market supply $S$ increases quadratically as producers move up the expected supply function, so that the possibility of costs exceeding revenue also increases. Clearly, the distortion in the market arises from the tradeoff between the surpluses from higher outputs and the net welfare loss associated with wasted resources.

The authors have explored the magnitudes of the optimal price distortions and associated welfare gains for different values of $\xi_d$ and $R$ within the confines of this simple market model (Hazell and Scandizzo, 1975). It was found that not only can the optimal price distortion be quite large when demand is inelastic (more than 10% with moderate production risks), but important welfare gains (about 2% for $R = 0.5$) may be had from using market intervention policies to introduce the desired distortion.

These results might appear to suffer from the rather stringent simplifying assumptions of the model. However, as shown below, the existence of an optimal distortion generalizes to much more complex market structures, though in these cases it is much more difficult to say anything about the size of the welfare gains without resorting to empirical situations.

2. GENERALIZATION TO AGRICULTURAL PROGRAMMING MODELS

An increasing number of formal agricultural sector models are now being built using mathematical programming techniques. Many of these models are

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4In an additive risk model, for example, with the same kind of lagged specification, a price distortion does not arise (see Turnovsky, 1974).
also structured to provide the perfect competition solution to all product markets when both prices and quantities are endogenous. In the deterministic case, and with suitable restrictions on demand, this is easily achieved by maximizing an objective function defined as the sum of consumers' and producers' surplus in all markets (Duloy and Norton, 1975; Samuelson, 1952; Takayama and Judge, 1964, 1971). For example, in a simple model of annual crop production based on a single aggregate farm facing the demand structure \( P = A - BWX \), the appropriate model maximand can be written as

\[
\text{Max } \Pi = X'W(A - 0.5BWX) - C'X
\]  

(11)

where

\( X = \text{an } n \times 1 \text{ vector of crop acreages grown} \)
\( W = \text{an } n \times n \text{ diagonal matrix of crop yields per acre} \)
\( C = \text{an } n \times 1 \text{ vector of costs per acre} \)

and \( A \) and \( B \) are \( n \times 1 \) and \( n \times n \) matrices of demand coefficients, respectively.

The term \( \lambda W(A - 0.5BWX) \) is simply the sum of areas under the demand schedules, while \( C'X \) is total production costs, or equivalently, the sum of areas under the supply functions. The difference between these two is, therefore, the sum of the consumers' and producers' surplus.

The maximand assumes farmers are profit maximizers, and provides equilibrium prices and output levels such that market prices equal marginal costs. Typically, (11) is maximized subject to a set of linear programming constraints of the form

\[
DX \leq b.
\]  

(12)

The authors have generalized this model to the risk case in which yields are stochastic and farmers are risk averse (Hazell and Scandizzo, 1974). In particular, if farmers maximize the utility function \( U = M - \phi S \) where \( \phi \) is a risk aversion parameter and \( M \) and \( S \) denote, respectively, the expected value and standard deviation of income, then under quite reasonable assumptions, the expected values of prices and quantities in a competitive equilibrium can be approximated by using the maximand

\[
\text{Max } U = X'W(A - 0.5BWX) - C'X - \Phi (X'\Gamma X)^{1/2}.
\]  

(13)

Here, \( W \) denotes the diagonal matrix of expected yields, \( \Gamma \) is an \( n \times n \) covariance matrix of crop revenues (price times quantity), and \( \Phi \) is a suitable average of individual farm risk parameters.

\footnote{The procedure requires that the demand matrix \( B \) be symmetric (Takayama and Judge, 1971; Zusman, 1969).}
This maximand is identical to (11) except that a new production cost, \(\Phi(XX^T)^{\frac{1}{2}}\), has been added. This is simply the compensation demanded by farmers for taking risks, and which is to be added to the area under the supply functions. The maximand can, therefore, still be considered as a sum of producers' and consumers' surplus over all product markets. In fact, it is the sum of surpluses as measured above the anticipated supply functions (Hazell and Scandizzo, 1974).

That (13) provides an equilibrium solution can be shown from the necessary Kuhn-Tucker conditions of the Lagrangian function

\[
L = XX^T (A - 0.5BWX) - CX - \Phi(XX^T)^{\frac{1}{2}} + \nu' (b - DX)
\]

where \(\nu\) is a vector of dual values. These necessary conditions evaluate at

\[
W(A - BWX) \leq C + \Phi XX^T (X^T XX)^{-1} + D\nu.
\]  (14)

Since \(E(P) = A - BWX\), the condition requires that for each crop, expected marginal revenue per acre, \(WE(P)\), be equal or less than the expected marginal cost. Expected marginal cost comprises own marginal cost \(C\) plus the marginal risk cost \(\Phi XX^T (X^T XX)^{-1}\) plus marginal opportunity costs as reflected in the dual values of the resources used by that crop \(D\nu\). For those crops which are nonzero \((X > 0)\), then by the complementary slackness conditions, (14) holds as an equality, in which case the expected values of marginal revenues and cost are equated.

Despite the specificity of this model, it does provide a good forum for generalizing the optimal distortion results, as well as providing a framework for empirical experimentation.

Theoretically, the model is appealing because it assumes the multiplicative yield structure: - output = yield multiplied by area planted, where area planted (the \(X\) variables) are price responsive. Further, since the supply structure is embedded in the model through a set of choice variables and resource constraints, the model incorporates nonlinearities, as well as such multiproduct considerations as covariances between crop revenues (the off-diagonal elements of \(\Gamma\)) and substitution in demand (the off-diagonal elements of \(B\)).

Before considering these generalizations, it is worth noting, that in as much as (13) can be interpreted as a welfare function, it is an \textit{ex ante} welfare measure. The producers' surplus, in particular, is simply the excess of expected utility as measured by the function \(U = M - \phi S\). This type of welfare function has frequently been used to analyze intervention policies in risky markets.

\[6\] A welfare interpretation of (13) is not necessary for obtaining a competitive equilibrium solution. Rather (13) can be viewed simply as a computational device or trick.
(Massell, 1969; 0i: 1961; Turnovsky, 1974; Waugh, 1974), but it is not the relevant welfare measure when production is lagged and yield risks are multiplicative. For this situation, we must return to the welfare measure used in (8). That is, to the sum of expected values of realized (ex post) consumers' and producers' surplus.

The appropriate welfare function can equivalently be expressed as the sum of expected values under the demand curves, minus the sum of areas under the anticipated supply functions. In the context of the sector model notation, this becomes

\[ E[SW] = E[X'\gamma (A - 0.5BNX)] - C'x - \Phi (X'TX)^{\frac{1}{2}} \]

\[ = X'WA - 0.5X'\gamma (BNX)X - C'X - \Phi (X'TX)^{\frac{1}{2}} \]

(15)

where \( N \) denotes the diagonal matrix of stochastic yields such that \( E[N] = W \).

This welfare function leads to a set of optimally distorted prices. To prove this, consider the Lagrangian function

\[ L = E[SW] + v'(b - DX). \]

Apart from the feasibility conditions in (12), the necessary Kuhn-Tucker conditions are

\[ \frac{\partial L}{\partial X} = WA - E(\gamma N)X - C - \Phi (X'TX)^{\frac{1}{2}} Dv \leq 0. \]

(16)

Now, \( E(\gamma N)X = V(\gamma N)X + WBWX \) where \( V \) is the variance-covariance operator. Substituting this into (16), and rearranging terms,

\[ W(A - BWX) \leq C + \Phi (X'TX)^{\frac{1}{2}} Dv + V(\gamma N)X. \]

Using the demand equations \( E(P) = A - BWX \), we finally obtain

\[ W E(P) \leq C + \Phi (X'TX)^{\frac{1}{2}} Dv + V(\gamma N)X. \]

(17)

This relationship between marginal revenue and cost is very similar to that obtained in (14) for the market equilibrium case. However, a new cost \( V(\gamma N)X \) appears on the marginal cost side, which gives rise to optimal price distortions. Using complementary slackness conditions, it can also be shown that (17) holds as an equality for all crops entering the solution at nonzero levels.

The cost \( V(\gamma N)X \) is highly interesting because it is a social rather than a private cost. The \( i \)th element of this cost vector can be written as

\[ \sum_i \text{cov}(\varepsilon_i, \varepsilon_j) b_{ij} x_j. \]
Thus, the price of the \( i \)th crop is distorted from its equilibrium price by a term which depends on the variance of the yield of that crop and its covariances with the yields of all other crops. The variance-covariance effects are, of course, measured in physical units, but are converted into money costs through the demand coefficients \( b_{ij} \). Since the signs of the covariances and the \( b_{ij} \) coefficients may be positive or negative, the distortion effects are indeterminate in sign. It is likely that some prices should be increased above equilibrium prices, but that others should be reduced. However, the size of these distortions and the associated welfare gains is a purely empirical question, and to this we now turn using a specific agricultural model of Mexico.

3. ILLUSTRATIVE APPLICATION IN MEXICO

3.1. The Model

An agricultural sector model, CHAC,\(^7\) already exists in Mexico and provided a suitable basis for this study. CHAC is a linear programming model which encompasses the supply — domestic and imported — and all demands — domestic and export — for 33 short cycle crops. It does not include livestock, forestry or long cycle crops. The model is an aggregate of regional submodels, which are linked through a national market structure (domestic and foreign) and by some common resource constraints. CHAC is a static equilibrium model and provides the perfect competition solution to all markets for both prices and quantities through use of the kind of maximand detailed in equation (11).

To keep this study within manageable limits, a smaller version of CHAC was used which included only selected areas of irrigated land. These selected areas represent eight of the more than 100 administrative districts of the Mexican Ministry of Water Resources. They are not contiguous districts, but are scattered throughout the arid agricultural areas of Mexico. The districts and their locations are as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Northwest</td>
<td>Culiacán, Comisión del Fuerte, Guasave, Río Mayo, Santo Domingo</td>
</tr>
<tr>
<td>North Central</td>
<td>Ciudad Delicias, La Laguna</td>
</tr>
<tr>
<td>Northeast</td>
<td>Bajo Río San Juan</td>
</tr>
</tbody>
</table>

\(^7\)CHAC, which names after the Mayan rain god, was constructed by the World Bank in collaboration with the Secretaría de la Presidencia in Mexico. A complete description of the model can be found in Duloy and Norton (1973) and Bassoco and Rendón (1973).
Table 19.1

Average district cropping patterns, 1967/68 to 1969/70
(Harvested hectares*)

<table>
<thead>
<tr>
<th>Crops</th>
<th>El Fuerte</th>
<th>Culiacan</th>
<th>Rio Mayo</th>
<th>Guasave</th>
<th>Deptpas</th>
<th>San Juan</th>
<th>Sr. Domingo</th>
<th>Lagunas</th>
<th>Aggregate</th>
<th>% of National Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>46.364</td>
<td>—</td>
<td>15.535</td>
<td>—</td>
<td>7.903</td>
<td>—</td>
<td>1.190</td>
<td>17.585</td>
<td>67.964</td>
<td>156.541</td>
</tr>
<tr>
<td>Green alfalfa</td>
<td>—</td>
<td>543</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>5.224</td>
<td>5.767</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>12.706</td>
<td>24.172</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Barley</td>
<td>1.112</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chilies</td>
<td>386</td>
<td>1.570</td>
<td>—</td>
<td>—</td>
<td>48</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Beans</td>
<td>16.224</td>
<td>11.024</td>
<td>—</td>
<td>—</td>
<td>202</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>561</td>
<td>938</td>
<td>—</td>
<td>—</td>
<td>271</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>3.049</td>
<td>9.563</td>
<td>—</td>
<td>—</td>
<td>381</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Sesame</td>
<td>3.010</td>
<td>2.815</td>
<td>8.390</td>
<td>—</td>
<td>144</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cabbage</td>
<td>231</td>
<td>397</td>
<td>—</td>
<td>—</td>
<td>722</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Potatoes</td>
<td>1.320</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>8</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Watermelons</td>
<td>757</td>
<td>325</td>
<td>—</td>
<td>41</td>
<td>—</td>
<td>74</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Soybeans</td>
<td>16.264</td>
<td>4.392</td>
<td>11.886</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>5.742</td>
<td>29.668</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Wheat</td>
<td>23.561</td>
<td>3.057</td>
<td>29.969</td>
<td>5.742</td>
<td>29.668</td>
<td>1.048</td>
<td>11.738</td>
<td>16.150</td>
<td>120.933</td>
<td>—</td>
</tr>
</tbody>
</table>

| TOTAL       | 177.576   | 122.825  | 93.158   | 18.634  | 61.853  | 76.457   | 31.744      | 106.641 | 688.888   | —                        | —                       |


| Available hectare per farm | 10 | 12 | 8 | 6 | 4 | 16 | 47 | 2 | 5.8 |

*Seeded hectares include significant amounts of double cropping in most districts.
Taken together, the 8 districts account for significant shares of the national production of cotton, tomatoes, dry alfalfa, rice, soybeans and safflower (Table 19.1). They also produce a wide range of cereal crops and vegetables, together with some sugar cane. Some double cropping is practiced in all the districts, but particularly in the vegetable growing areas. The average district cropping patterns for the years 1967/68 to 1969/70 are given in Table 19.1, but excluding a small percentage of land devoted to crops which are not included in the models. Crop production is almost entirely dependent on irrigation in all 8 districts, and small areas of rainfed land have been excluded.

In total, the 8 district models cover 99,000 farms of an average size of 5.8 hectares — a district breakdown is included in Table 19.1. For modeling purposes, each district is treated as a single large farm. The farms are thought to be sufficiently homogenous, that this procedure is unlikely to lead to any serious aggregation bias problems. The model activities provide for the production, in each district, of the crops grown by that district in Table 19.1, each with a choice of 3 mechanization levels and 2 planting dates. A set of labor activities provide flexibility in selecting seasonal combinations of family and hired day labor. Family labor is charged a reservation wage of one-half of the hired day labor rate. Purchasing activities provide for the supplies of mules, machinery and irrigation water. Seasonal constraints are imposed on land and labor, and an annual constraint is imposed on water supplies. Technical coefficients and costs are taken at average levels from 1967/68 to 1969/70. The model constraints are also based on this period. Average yields are based on the 6-year period from 1966/67 to 1971/72, and risk parameters were estimated from time series data spanning the period 1961/62 to 1970/71.

The district models are linked in block diagonal form and integrated into an aggregate market structure, similar to that in CHAC. That is, the market comprises linear domestic demand functions of the form \( P = A - BWX \), and has import and export possibilities at fixed prices. To approximate cross-elasticity relationships in demand, the crops are classified into demand independent groups, and linear substitution is allowed between products within each group at rates fixed by base year relative prices. The definition and characteristics of these demand groups are summarized in Table 19.2. The demand curves for each group have the same price elasticities as in CHAC, but are located at mean output levels appropriate for the 8 district aggregates. Export and import constraints are also pro-rated according to the ratio of output from the 8 districts to national output for each product.

The resultant model was solved for equilibrium values of expected prices and quantities using the type of maximand detailed in equation (13). That is, assuming farmers maximize \( M = \phi S \) utility. The model was also solved for optimal price distortions using the welfare function defined in equation (15) as

\[ \text{For a more detailed description, see Dukow and Norton (1973, 1975).} \]
### Table 19.2
Characteristics of demand groups

<table>
<thead>
<tr>
<th>Demand group</th>
<th>Commodity</th>
<th>Base period price (Pesos/ton)</th>
<th>Group index&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Own price elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sugar cane</td>
<td>70</td>
<td>70</td>
<td>-0.25</td>
</tr>
<tr>
<td>2</td>
<td>Tomatoes</td>
<td>1150</td>
<td>1150</td>
<td>-0.4</td>
</tr>
<tr>
<td>3</td>
<td>Chillies</td>
<td>1500</td>
<td>1500</td>
<td>-0.2</td>
</tr>
<tr>
<td>4</td>
<td>Cotton fiber</td>
<td>5770</td>
<td>5770</td>
<td>-0.5</td>
</tr>
<tr>
<td>5</td>
<td>Dry alfalfa</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green alfalfa</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>930</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chickpeas</td>
<td>990</td>
<td>446</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>860</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td>630</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rice</td>
<td>1220</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Beans</td>
<td>1830</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chickpeas</td>
<td>990</td>
<td>1285</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>Potatoes</td>
<td>930</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Maize</td>
<td>860</td>
<td>817</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cantaloupe</td>
<td>680</td>
<td>741</td>
<td>-2.0</td>
</tr>
<tr>
<td></td>
<td>Watermelons</td>
<td>780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Safflower</td>
<td>1550</td>
<td>1164</td>
<td>-1.2</td>
</tr>
<tr>
<td></td>
<td>Sesame</td>
<td>2410</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cotton oil</td>
<td>830</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soybeans</td>
<td>1600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cucumbers</td>
<td>590</td>
<td>590</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

<sup>a</sup> Group price indices are computed using base year quantity weights (Dukoy and Norton, 1973, 1975).
the model maximand. In both cases, the aggregate risk aversion parameter \( \phi \) was varied in order to evaluate the effects of different levels of risk averse behavior on the model solutions. Solutions for \( \phi = 0 \) correspond, of course, to the risk neutral case in which farmers simply maximize expected profits.

3.2. The Results

In Table 19.3, the values of social welfare, as measured by equation (15), are reported for both the equilibrium and optimally distorted solutions for different values of \( \phi \).

These welfare gains are much larger than suggested by the earlier theoretical analysis for the single product case. For \( \phi = 0 \), for example, optimal market distortion policies could increase social welfare by as much as 6.4 per cent or an equivalent of 270 million pesos. Since it can be shown that the welfare gain accrues entirely to producers (Hazell and Scandizzo, 1975), this would be equivalent to an average gain of 2,727 pesos per farm.

The welfare gain obtainable from optimal distortion policies diminishes as \( \phi \) increases. This suggests that private risk costs are positively correlated with the social risk term responsible for the distortions, the former tending to substitute for the latter as \( \phi \) increases. Indeed, when \( \phi = 2.0 \), the gains from optimal distortion policies are quite trivial at 20 million pesos. Private risk aversion might therefore be considered desirable because it tends to restore competitive market efficiency.

The optimal price distortions are summarized in Table 19.4 for different values of \( \phi \). Since the relative prices of commodities within demand groups are fixed at base year values, only the group price indices are reported. Table 19.4 reports the value of these price indices at market equilibrium for each value of \( \phi \), as well as the percentage distortion required to maximize social welfare.

As expected, most of the distortions involve price increases and, hence, reductions in domestic market supplies. A few negative price distortions do occur, particularly for larger values of \( \phi \), and which have their origin in negative yield covariances both between crops and between irrigation districts.

Many of the price distortions are quite large despite opportunities for world trade at fixed prices. In fact, only the price of cotton fiber (group 4) is consistently pegged at its export value. The price distortions are largest for low volume specialist crops — chillies (group 3), cantaloupes and watermelons (group 5) and cucumbers (group 10) — and smallest for the important food and wage good crops — wheat and maize (group 7). The magnitude of the distortions tends to diminish as \( \phi \) increases, but they do not disappear when \( \phi = 2.0 \), even though the welfare gain becomes very small.

The international trade results are summarized in Table 19.5. The optimally distorted solutions call for greater levels of exports and imports, and a larger trade surplus, for all values of \( \phi \). This result arises in part because export and import prices are fixed and nonrisky in the model. More realistic
Table 19.3
Welfare gains with various \( \Phi \) values

<table>
<thead>
<tr>
<th>Item</th>
<th>Values of ( \Phi )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Social welfare</td>
<td></td>
</tr>
<tr>
<td>Equilibrium model (billions of pesos)</td>
<td>4.21</td>
</tr>
<tr>
<td>Distorted model (billions of pesos)</td>
<td>4.48</td>
</tr>
<tr>
<td>Gain from distortion (%)</td>
<td>6.4</td>
</tr>
<tr>
<td>Gain to average farm (pesos)</td>
<td>2727.0</td>
</tr>
</tbody>
</table>

Table 19.4
Optimal distortions in domestic prices for various \( \Phi \) values

<table>
<thead>
<tr>
<th>Demand group</th>
<th>( \Phi = 0.0 )</th>
<th>( \Phi = 0.5 )</th>
<th>( \Phi = 1.0 )</th>
<th>( \Phi = 1.5 )</th>
<th>( \Phi = 2.0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( p^b )</td>
<td>( T^c )</td>
<td>( P )</td>
<td>( T )</td>
<td>( P )</td>
</tr>
<tr>
<td>1</td>
<td>68</td>
<td>10.3</td>
<td>68</td>
<td>7.3</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>330</td>
<td>29.7</td>
<td>705</td>
<td>7.2</td>
<td>1071</td>
</tr>
<tr>
<td>3</td>
<td>700</td>
<td>318.1</td>
<td>741</td>
<td>302.2</td>
<td>748</td>
</tr>
<tr>
<td>4</td>
<td>5770</td>
<td>0.0</td>
<td>5770</td>
<td>0.0</td>
<td>5770</td>
</tr>
<tr>
<td>5</td>
<td>410</td>
<td>18.5</td>
<td>415</td>
<td>6.3</td>
<td>432</td>
</tr>
<tr>
<td>6</td>
<td>1279</td>
<td>28.4</td>
<td>1200</td>
<td>36.9</td>
<td>1158</td>
</tr>
<tr>
<td>7</td>
<td>991</td>
<td>-1.6</td>
<td>931</td>
<td>0.0</td>
<td>938</td>
</tr>
<tr>
<td>8</td>
<td>309</td>
<td>104.9</td>
<td>368</td>
<td>62.2</td>
<td>434</td>
</tr>
<tr>
<td>9</td>
<td>1052</td>
<td>7.8</td>
<td>1037</td>
<td>7.6</td>
<td>1089</td>
</tr>
<tr>
<td>10</td>
<td>569</td>
<td>1.8</td>
<td>681</td>
<td>3.1</td>
<td>838</td>
</tr>
</tbody>
</table>

(a) The demand groups are in Table 19.2.
(b) \( p^b \) denotes the equilibrium price index for a commodity group in pesos/ton.
(c) \( T \) denotes the optimal market price distortion for a group from its equilibrium value \( P \) expressed in per cent.
Table 19.5

International trade results
(million of pesos)

<table>
<thead>
<tr>
<th>Item</th>
<th>Values of $\Phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Equilibrium model</td>
<td></td>
</tr>
<tr>
<td>Value exports</td>
<td>196.96</td>
</tr>
<tr>
<td>Value imports</td>
<td>0.07</td>
</tr>
<tr>
<td>Trade surplus</td>
<td>196.89</td>
</tr>
<tr>
<td>Optimally distorted model</td>
<td></td>
</tr>
<tr>
<td>Value exports</td>
<td>213.66</td>
</tr>
<tr>
<td>Value imports</td>
<td>8.46</td>
</tr>
<tr>
<td>Trade surplus</td>
<td>205.20</td>
</tr>
</tbody>
</table>

assumptions might have reduced the levels of trade in the optimally distorted solutions, but only if world prices are at least as risky as domestic prices.

4. CONCLUSIONS

In this chapter, we have attempted to demonstrate, within the bounds of an agricultural subsector model, that competitive market equilibria may be far from efficient in terms of social welfare when production is risky. The potential welfare gains to be had from optimal intervention policies are surprisingly large, in fact, far greater than might be anticipated from simple algebraic models. We have not considered the distributional aspects of the welfare gain in this chapter, suffice to say that the main benefits lie with the farmers, while consumers tend to lose. Implementation of an optimal distortion scheme might need to be supplemented with some kind of taxation scheme to obtain appropriate redistribution of the gains.
The results in this chapter do, of course, hinge on the welfare measured used. The measure of producers' surplus presents few problems (it is simply average realized profits), but the expected consumers' surplus is more objectionable. Basically, it ignores the income effects incurred by consumers from increasing food prices, and which, in a country like Mexico, must be expected to be quite large, especially for the magnitude of price changes envisaged here. We are encouraged, however, by the fact that the price of the basic wage goods — maize and wheat — are hardly changed in the optimally distorted results. Consequently, the major price effects would impinge upon the incomes of the more prosperous nonagricultural households, effecting an interesting transfer of income to the rural areas.

So far, we have avoided the question of how optimal market distortions could be implemented. An obvious and simple procedure in autocratic societies would be to introduce production quotas at the regional level. However, more sophisticated intervention policies can be devised for free market situations through the design of optimal buffer stock and price stabilization schemes. This, however, is a topic which cannot be embarked upon here.

5. POSTSCRIPT

Newbery, in his comments on this chapter, argues that the distortion results obtain only because it is assumed that farmers plan each period on the basis of independent forecasts about prices and yields. He shows that more rational expectations which take account of negative correlations between prices and yields would lead to market equilibria which are efficient. The authors have subsequently shown (Hazell and Scandizzo, 1977) that there exists an even simpler class of behavioral models which ensure competitive market efficiency, namely those models in which farmers are assumed to act on the basis of a linear lagged function of past (per unit) revenues. The position is now such that results about competitive market efficiency and the need for government intervention policies depend very much on the way farmers actually do forecast enterprise profitability each year when planning their input decisions. Given the magnitudes of the welfare losses demonstrated in this chapter for reasonable but less than optimal behavior, there is a clear need for empirical research to determine how farmers do behave.
Part VIII

Summary, conclusions and directions for new research
Chapter 20

Risk and uncertainty in agricultural development: An overview

Hans P. Binswanger

In trying to understand the role of risk and uncertainty, we are basically concerned with (i) how risk and uncertainty affect the efficiency of production and investment decisions by individuals, firms, and governments (i.e., what are the growth implications), (ii) how risk and uncertainty affect the distribution of income and wealth among households, and (iii) how risk and uncertainty affect policy prescriptions and the effectiveness of policy tools.¹

In Table 20.1, these basic reasons are further broken down into question complexes or concerns in which the attitude towards risk of the actors or decision makers involved may potentially have a major influence. All these question complexes and actors were considered at the conference although some received much less attention than others.

Among the actors whose attitudes towards risk might matter, only farmers received much attention at the conference. The areas receiving most attention were the consequences of attitudes towards risk for the adoption of technology (Area 1), for price and stabilization policy (Area 7), and for rural institutions such as sharecropping (Area 6). Little was said about regional

¹Anderson in Chapter 3 of this volume, distinguishes between (1) normative, (2) predictive and (3) analytical uses of models of decision making under risk (Anderson, Table 3.1). For developing countries normative uses will, for a long time to come, be confined to the analysis of large investment decisions. Such models will not become a farm management tool for use in planning individual farms or even for groups of farms. Analyst's time investment for that is simply too large for the payoffs which can be expected from such applications.

The main applications can therefore be expected to occur in trying to predict future actions of groups of individuals and in analytical uses with a goal of either improving methodology or influencing policy. These notes will therefore pay little attention to normative uses of models of behavior under risk, with the exception of potential uses in regional or national planning exercises.
<table>
<thead>
<tr>
<th>Concerns</th>
<th>Actors whose attitudes towards risk are involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Adoption of profitable but risky technology by farmers (with emphasis on efficiency implications)</td>
<td>Farmers</td>
</tr>
<tr>
<td></td>
<td>Money lenders</td>
</tr>
<tr>
<td></td>
<td>Credit institutions</td>
</tr>
<tr>
<td>2) Income-distribution implications of differential risk aversion and its implication for crop choice, adoption behavior, and credit use (who will grow/survive in a dynamic environment)</td>
<td>Farmers</td>
</tr>
<tr>
<td></td>
<td>Money lenders</td>
</tr>
<tr>
<td></td>
<td>Credit institutions</td>
</tr>
<tr>
<td>3) Regional planning and investment strategies, <em>e.g.</em>, whether to concentrate investment on high-potential/low-risk regions or not</td>
<td>Policy makers</td>
</tr>
<tr>
<td></td>
<td>Administrators</td>
</tr>
<tr>
<td></td>
<td>Donor agencies</td>
</tr>
<tr>
<td>4) Agricultural research strategy, <em>e.g.</em>, on which regions to concentrate research investment, or what emphasis to give on stability of technology as against productivity</td>
<td>Farmers</td>
</tr>
<tr>
<td></td>
<td>Researchers</td>
</tr>
<tr>
<td></td>
<td>Research administrators</td>
</tr>
<tr>
<td>5) Attitude towards risk as determinants of rural institutions (e.g., sharecropping)</td>
<td>Farmers/landowners</td>
</tr>
<tr>
<td></td>
<td>Laborers (Potential sharecroppers)</td>
</tr>
<tr>
<td></td>
<td>Leaseholders</td>
</tr>
<tr>
<td>6) Take account of attitudes towards risk in output supply analysis</td>
<td>Farmers</td>
</tr>
<tr>
<td>7) Increase utility by reducing fluctuations in outputs, prices, and incomes (price and output stabilization)</td>
<td>Farmers</td>
</tr>
<tr>
<td></td>
<td>Consumers</td>
</tr>
<tr>
<td></td>
<td>Government</td>
</tr>
</tbody>
</table>
investment strategies (Area 3), which may explain why the attitudes of planners and policy makers did not receive much attention. While distributional effects (Area 2) figured prominently as a concern, little formal analysis has yet been done on this topic.

In none of the areas was the conference able to clearly come to an agreement as to whether risk and uncertainty had a strong influence on the actors’ behavior. If adverse growth or equity implications were likely to result from the influence of risk and uncertainty, the conference was not able to agree on policy measures either. This chapter is an attempt to understand the reasons why agreement was not reached on any of these questions.

In doing research on policy questions in which risk aversion might play a role, the following four problems have to be solved:

1. How should the decision process of the actors involved be modeled?
2. What are the probability distributions of the outcomes of the alternatives available to the decision makers? (Depending on the context or the model, these will be objective or subjective probability distributions.)
3. Are the decision makers sufficiently risk averse (or risk preferring) to make it necessary to take divergences from expected profit maximization into account in predictions and policy recommendation? Who are the decision makers whose risk aversion counts?
4. If risk aversion has adverse efficiency or distributive consequences, what can be done in terms of policies to redress these consequences, i.e., what are the policy instruments available?

In the remainder of this chapter, I will try to trace the disagreements which surfaced at the conference to more specific disagreements on the above four questions. I will use the concern about the effect of risk aversion on adoption of technology as the main example, and not give much emphasis to any other question complex discussed at the conference. It is not that the other questions are unimportant, but my own interest is primarily in the area of adoption.

1. MODELING QUESTIONS

On the methodological side, the conference concentrated heavily on optimizing methods (see e.g., Anderson, Table 3.2, and Roumasset, Ch. 1). In particular, two groups of models were strongly contrasted:

(a) Models based on a utility function (Bernoullian and Bayesian decision models); and
Much of the time was spent on differentiating these models, but in order to make further progress, it seems necessary to emphasize their common aspects and the common methodological problems which confront them at this time.

One point which has been emphasized several times is an apparent similarity of predictions of the two classes of models. Of course, this is still a somewhat casual impression. In a few cases, models from both classes have been applied to the same problem on the same agricultural data set from developing countries. Identification of most researchers with either of the approaches usually prevents such comparisons.

A second similarity of the approaches is that both require some knowledge about the attitudes towards risk of the decision makers whose decision is modeled. The utility-based approaches require the elicitation or estimation of the utility function, with all the potential misgivings one might have about any actual procedure to do this. The simpler safety-based approaches typically require the elicitation of disaster levels of income, focus losses, flexibility constraints, or safety zones.

Unless one chooses these simpler representations of attitudes arbitrarily, or bases them on some past observed income requirements, I cannot see why their elicitation or econometric estimation should be easier or less hazardous than elicitation of utility functions. ¹

Most importantly, all the major approaches are now based on personal or subjective probabilities of outcomes of different choices. In comparison to the emphasis placed on attitudes towards risk and their determinants, little was said at the conference about personal probabilities, except that Dillon’s paper listed the difficulties encountered in eliciting them and there was agreement that eliciting probabilities is indeed more difficult than eliciting attitudes towards risk. However, it seems to me that many methodologies, disputes, and many important empirical questions will remain unresolved until more knowledge exists about how personal probabilities are formed and revised. ²

For the adoption question, the manner in which subjective probabilities are formed makes a great deal of difference in the distributional outcomes of a sequence of innovation cycles. The capacity to learn new probability distribution accurately is crucial for successful early adoption. In a modernizing agriculture, innovators’ rents to early adoption of new

¹See Kennedy’s paper, Chapter 9.
²Two models of learning were presented at the conference, one based on Bayesian theory which fits well into the utility-based theories (see Dillon 1976), and the other on Day’s model of learning by a cautious optimizer.
technology may have major effects on intrafarm income distribution and survival, and who captures them is an important distributional question.\textsuperscript{4}

The interaction of risk and learning is important and is emphasized by the conclusions of Hazell and Scandizzo’s paper. The authors state that optimally distorted prices of risky commodities may improve aggregate welfare over the levels reached at competitive equilibrium. However, this conclusion is totally dependent on the process by which expectations about risky outcomes are formed, as Newbery has shown. Hazell and Scandizzo assume a simple distributed lag process of expectation formation with independence of price expectations from quantity expectations. When this model of expectations is replaced by a rational expectation mechanism of profits, which takes covariances between marketed quantities and prices into account, no aggregate welfare gains accrue from distorting prices in the way proposed by Hazell and Scandizzo.

Since the utility-based models and the “safety” models lead to similar predictions, encounter similar problems in eliciting information about the actors’ attitudes, and both need to take better account of learning behavior, little will be gained from further model differentiation at this stage. For further progress, we will require empirical rather than theoretical answers. We, therefore, turn to empirical questions about probability distributions of outcomes and extent of risk aversion which are germane to the whole adoption question and many policy issues.

2. **PROBABILITY DISTRIBUTIONS OF OUTCOMES**\textsuperscript{5}

Most of the models of behavior under risk are built in terms of personal probabilities of outcomes. No paper was presented at this conference in which elicitation of subjective probability distributions on substantial numbers of farmers had been done. However, Gerald O’Mara, in a study not reported at

\textsuperscript{4} Risk aversion and learning speed affect adoption in two different ways. Fertilizer adoption may be permanently below the profit-maximizing level because the utility maximizing level which takes risk aversion into account, is lower than the former. In terms of efficiency considerations, this is the most important question. If risk aversion is negatively associated with wealth, it will also affect income distribution since the poorer groups would remain further away from profit maximizing levels than the richer groups. These effects would be permanent, whereas, learning speed has only temporary effects. If capacity and incentive to learning are also negatively associated with wealth, the poorer groups will not share in innovators’ rents, even if they accept innovations — such as fertilizers — up to their utility maximizing level after a lag.

\textsuperscript{5} The discussion of how to define risk in the first place is reviewed in the introduction. Bousard, in following Shackle, raised the issue that farmers cannot be expected to hold well defined probability distributions of outcomes and that some simpler devices such as focus loss deserve more attention. Our experience in India suggests that as far as yields are concerned, farmers themselves reason in terms of “so many years out of so many,” which is a well defined probability concept. Distributions of prices and, therefore, gross returns may be much less well defined and simplified approaches may be more appropriate there.
the conference, elicited personal probability distributions for two maize
growing techniques under irrigation in Mexico from 84 farmers and did not
report unusual difficulties. In most cases, the modern methods did not seem to
be subjectively more risky than the traditional one. Note, however, that
several studies have shown that analysts can influence to a large extent the
subjective probability distributions elicited.⁶

Roumasset (1976) developed an approach of combining personal
probabilities of certain “disasters” such as major pest outbreaks and typhoons
with experimentally derived production functions to arrive at subjective
expected production functions for fertilizer on rice. His approach is an advance
since it is simpler to elicit probability distributions of disastrous events than of
yields. For example, most farmers are able to specify the number of severe
drought years they expect in a 10-year period.

Using this approach for a well developed area in the Philippines, he found
that fertilizer applications do not substantially increase financial risk and,
therefore, risk aversion cannot be the primary cause of fertilizer applications
which fall seriously short of profit maximizing levels, regardless of whether
farmers are risk averse or not.

However, most empirical studies will continue to work with objective
probability distributions, and even in this, our empirical knowledge is very
limited. An exception is the study of Ryan and Perrin in which they derived a
response function for potatoes in Peru, using data from 90 experimental trials
conducted over 65 sites between 1960 and 1970.⁷ The response function
included soils and weather variables. Risks of different fertilizer doses was
derived by combining the response functions with more than 40 years of
weather data. Risks from other sources were not considered. The conclusion
reached is that weather risk does increase with increased fertilizer doses on
average and deficient soils, but on soils containing high levels of organic
matter, risk first decreases and then only increases with higher levels of
fertilizers. The conclusion, thus, differs from that of O'Mara and Roumasset.
One of the reasons might be that potatoes are a rainfed crop and, thus, much
more subject to rainfall variations than irrigated maize or rice.⁸

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⁶See Dillon for a discussion on elicitation studies and Kunreuther for the special problems
associated with low probability events.

⁷This massive data gathering effort had been done by R.E. McCollum, Carlos Valverde S.
and Sven Villagarcia. It is most unusual that the data were collected in a form which allowed its
retrieval for the response-function analysis.

⁸This explanation of the difference in findings is strengthened by the Ryan and Perrin finding
of lower riskiness in soils with high organic matter, which usually implies high moisture holding
capacity and less risk of drought.
Apart from the evidence of O'Mara, Roumasset, and Ryan and Perrin, there remains a very large gap in our knowledge about objective or subjective probability distributions. For objective distributions, this might be attributed to the following reasons:

(a) *Ex ante*, that is, before a new practice is adopted anywhere, the information available is experiment station data. These experiments are usually conducted under conditions far superior to the average farm that they largely overstate the expected response of yield to fertilizers or other practices. In a few countries, experiment station data are supplemented by trials in farmers' fields but again the better farmers are usually included in those and, due to the small number of years of these trials, it is relatively difficult to separate the time series component of variability from the cross section component. However, the recent trend towards more and prolonged experimentation in farmers' fields is the avenue by which advances must come.

(b) The most frequently used approach to derive probability distributions of yields is to simply assume that aggregate regional or district level data correctly reflect yield variabilities at farmers' fields levels. Apart from problems of aggregation, probability distributions of new practices (say, fertilizer levels) or new varieties cannot be derived in this way without the strong assumptions of either additive or multiplicative shifts in production functions. This is not so much due to the well known fact that aggregate regional data underestimate year to year variability in farmers' fields than to the difficulty of getting aggregate data by variety and fertilizer level.

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9In the Philippine rice study of Roumasset (1976), most of the inefficiency in farmers' fertilizer use disappear once the experiment station production function is corrected to reflect farmers' situations.

Even the analysis of experiment station data over time has not frequently been pursued much beyond Janvry's and the Ryan and Perrin contribution. One of the reasons is that few experiments are carried out for more than 2 or 3 years, which is insufficient for reliably estimating such distributions (For the difficulties encountered, see Anderson, 1973b). More promising may be the use of variance component models on experiments at several or many locations over a number of years. In an unpublished paper, Minhas and Srinivasan have started in this direction. The Evenson, et al. chapter was a further attempt in this direction. Evenson and I are continuing in this direction with the goal of getting more precise estimates of general adaptability and time series stability for varieties by using the widespread and relatively long duration experiments of international and some national research organizations.
Farm level data for both old and new practices for many years are almost nonexistent in developing countries because few farm record schemes have been in operation long enough. Furthermore, one cannot get data on new practices from historically recorded farm level data.

Given these difficulties, more indirect methods may have to be used to test the “risk retards adoption” hypothesis. For example, income variability from cash crops usually exceeds income variability of subsistence crops, due to the usually higher price variability of the former. Wolgin uses this fact to establish and test the hypothesis that risk-averse farmers should allocate inputs to cash and subsistence crops in such a way that the value of marginal products of any input in a high risk crop should be lower than in a low risk crop. Such a finding supports the hypothesis of risk aversion of farmers without requiring much information about the precise distributions of yields or net returns.

Similarly, it may be possible to push the analysis of the “risk retards adoption” hypothesis further by some broad classifications of technologies into different groups according to how they affect yield and gross or net return distributions. Clearly, practically all new technologies which are likely to be adopted increase expected outputs or yields, i.e., shift and/or change the shape of the yield distributions to increase expected yields. Furthermore, most of the new technologies result in shifts which may not increase yield risks very much. However, what happens to riskiness of net returns depends on (a) the investment levels associated with the new technologies (the smaller the less risky) and (b) how the yield distributions shift or change their shapes. With respect to (b), it should be possible to classify technologies into three groups (two of which were well recognized at the conference, see Carlson, Ch. 11.)

1. **Nonprotective inputs** such as new seeds or fertilizers shift the probability distribution of yields without necessarily decreasing probability levels at the lower tail of the yield distribution.

2. **Protective inputs** such as pesticides and varieties introduced specifically for disease resistance (and not for increases in yield potential) increase

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10In India, certain farm management studies are an exception, and with access to the original data, probability distributions of existing practices could be estimated. At the International Center for Crops Research Institute for the Semi-Arid Tropics (ICRISAT), we are experimenting at the present time with using data from crop cutting surveys for 5 years collected by the Andhra Pradesh Government to estimate aggregate yields and production. We had access to the original questionnaires which provide a certain amount of information on varieties, soil quality, and input use. We will try to use variance component production function models to estimate variability over time and by practice.
expected yields primarily by reducing probability levels at the lower tail of the distribution but do not tend to increase yields under favorable circumstances.

(3) *Inputs with dual role.* Investments such as irrigation which increase potential maximum yields as well as reducing frequencies at the lower end of the distributions (by avoiding drought, for example).

The paper by Richard Just and Rulon Pope in this volume suggests econometric methods based on production functions which, for the first time, would allow the testing of this classification empirically if good data are available.

If farmers are risk averse, they should overinvest in protective inputs and dual role inputs and underinvest into nonprotective inputs.\(^{11}\) If we observe underinvestment into protective inputs (when valuing capital at an institutional interest rate), we must conclude that credit constraints are at the root of the problem, unless we assume risk preference or information gaps. Underinvestment relative to the expected profit maximizing point for risk averters can, thus, only be a problem with respect to nonprotective inputs, primarily fertilizers, labor, or machinery inputs for better agronomic practices such as weeding and land smoothing. (In the case of seed varieties, riskiness of net returns will generally not increase due to the small investment required for seeds relative to the increase in expected yields.)

In the case of the nonprotective investments, the fine balance between the size of the investment and the shift in probability distribution will determine whether risk of net returns is increased or not. Clearly, the smaller the capital investment relative to a given expected gross return, the smaller the probabilities that a nonprotective input increases risk.

One of the major competing hypotheses for explaining lack of adoption, especially of fertilizers, is the existence of credit constraints or extremely high costs of borrowing to small holders. The other major competing hypothesis is Roumasset's "Fertilizers do not increase risk if probability distributions are properly measured."

One way of testing whether the risk or credit constraint explanation is correct is to see whether adoption of all three classes of inputs fall below the expected profit-maximizing level or whether only the levels of nonprotective inputs fall short of it (note that the comparison should include only inputs requiring cash outlays).\(^{12}\) If underinvestment occurs for all inputs equally,

\(^{11}\) Carlson reports a case of overinvestment in pesticides for cotton in Central America.

\(^{12}\) Wolgin makes a comparison for fertilizer and family labor and finds that input levels are much closer to profit-maximizing optima for labor than for fertilizer. But this divergence can again be due to either credit constraints or risk or both since labor is largely a noncash input.
credit will be the overriding constraint, whereas risk is more important if underinvestment is restricted to the nonprotective inputs.

3. RISK AVERSION

Suppose it can be established for many nonprotective modern inputs that they do indeed increase riskiness of net returns. Whether this is of any consequence depends on the extent of risk aversion among farmers. Hence, for this question, as for many others, empirical estimations of risk aversion or safety zones and parameters of caution, for that matter, becomes crucial. Measurement of attitudes becomes more important as it becomes more difficult to precisely measure subjective or objective probability distributions of outcomes of choices, because one may sometimes be able to infer the subjective probabilities if he knows the actual behavior and the attitudes of the actor.

The discussion on risk attitudes at the conference is extensively reported in the introduction. Roumasset rightly stresses the substantial progress made with econometric approaches by Just and Pope, using systems of factor demand equations which take risk into account. None of these models has yet been applied in developing countries.

Scandizzo and Dillon reported good success on eliciting risk attitudes with interview methods of about 130 farmers in Northeastern Brazil. This is an unusually large sample and it seemed feasible to use trained investigators. I have recently used the Scandizzo-Dillon approach on 240 households in semi-arid tropical India and tested the replicability of the methodology by reinterviewing 200 of the households one or two months later. Some were reinterviewed by the same investigators, but in most cases, investigators were rotated. The reinterviews led to evidence of nonreplicability of the methodology over time and to massive evidence of investigator bias. These findings will be reported in a forthcoming paper.

At the conference, Kennedy reported on a new interview method using the focus-loss approach which requires more sophisticated interviewers and farmers than the Scandizzo-Dillon approach. Before his approach can be accepted, it will be necessary to test for its replicability over time and across interviewers.

Another approach, which was not reported at the conference, is also econometrically based, but with cross section data from individual farms in mind. It consists of a more systematic comparison of the marginal product of a factor at the expected profit-maximizing optimum with the marginal product at the observed farmer's position, using an econometrically measured production function. Moscardi (1976) defines a residual "risk" measure out of this difference and uses it to study fertilizer applications in the Puebla project area in
Mexico. Wolgin looks at these discrepancies for many inputs across crops in Kenya without explicitly deriving a risk measure out of it. However, these differences or residual "risk" measures may have other causes, such as varying credit costs to sample farmers. This shortcoming is especially severe if only one input on one crop is considered.13

4. POLICY ALTERNATIVES TO DEAL WITH UNDESIRABLE CONSEQUENCES OF RISK AVERSION

Even if we had much more empirical knowledge about probability distributions, risk aversion coefficients, and the behavior of development actors under risk, and if we knew more about consequences for the development process, what could be done with such knowledge? One would, of course, want to incorporate it into government policies to deal with the concerns of Table 20.1 and ultimately to achieve greater efficiency or equity. Table 20.2 lists some of the policies and policy instruments which one may want to use to alleviate undesirable consequences of risk aversion, if one knew enough about the importance of these consequences.

This list, which is not exhaustive, has been subdivided into two classes on the basis of whether agricultural risk reduction or risk spreading is the primary goal of a policy. It is recognized that there is some arbitrariness in the classification. A policy is classified as risk specific if it reaches its ultimate efficiency or equity goals primarily via the effect which its risk spreading or reducing impact has on farmers' behavior towards the choice among risky production processes. A policy is classified as nonrisk specific if its main effect on efficiency or equity is not reached primarily as a consequence of risk spreading or reducing, but in a more direct way. For example, land distribution achieves its equity implication primarily because it gives more assets to the poor. As a consequence, the risk level of these people may be reduced, which in turn may allow them to make decisions closer to the expected profit-maximizing optimum; this is a secondary effect.

The most obvious risk specific policy is crop or credit insurance, but as both Oury (1976) and Gomez (1976) have shown, pure insurance schemes based on individual loss assessment are almost infeasible in countries with low levels of income and small landholdings. Administrative costs of individual loss assessment become just too high. Even in developed countries, generalized crop insurances, except for very specific risks such as hail, have only recently

13Wolgin gets most of his conclusions from comparing the discrepancies in marginal products across crops of the same farmers, which eliminates many other explanations than risk, since credit costs for the same input will be the same on two crops for the same farmer. Moscardi argues that his residual is not confounded with credit constraints because all farmers had equal access to credit in the Puebla project area.
Table 20.2
Policy alternatives to deal with undesirable consequences of risk aversion

A. Policies specific to agricultural risk

A-1 Crop/credit insurance, loan guarantees, etc.
A-2 Relief and famine policies
A-3 Pure buffer stock or price stabilization schemes
A-4 Plant protection by groups of farmers
A-5 Flood protection
A-6 Breeding for crop yield stability

B. Policies which are not risk specific

B-1 Subsidization of inputs and/or credit
B-2 Agricultural price support as income policy
B-3 Allocation of investment and research resources to regions
B-4 Reduction in background risk
   — irrigation investments
   — increase efficiency of markets (roads, market information, etc.)
   — improve access to information about technologies (extension, demonstration, etc.)
   — improve nonagricultural job opportunities
   — improve medical and other welfare policies
B-5 Legislation, regulation, institutional reform in areas such as credit and land tenancy
B-6 Land reforms and other income/wealth distributions.

become self-liquidating. In many cases, they still depend on heavy government subsidies. And in developing countries, where they have worked at all, they are better described as income support and distribution schemes towards poor areas than as insurance schemes.\textsuperscript{14} Furthermore, such schemes seem to work only when they are compulsory, which immediately leads to the question whether they improve welfare at all.\textsuperscript{15}

\textsuperscript{14} They are likely to be inefficient distributive devices and direct resource investments may be more appropriate to deal with regional disparities.
\textsuperscript{15} See, for example, the Mexican Credit Insurance Case discussed by Gomez (1976).
In the absence of insurance, most developing countries deal with the consequences of the worst disasters which hit their populations by more or less ad hoc relief policies, which range from land tax concessions to rural works and direct shipments of foods, feeds, and supplies. Despite heated debates about the adequacy and appropriateness of specific efforts, these policies may be the only effective insurance and risk-diffusion schemes available to poor countries to alleviate the effects of disasters. A more thorough investigation of the ability of these schemes to meet risk-reducing goals is surely called for.16

Buffer stock schemes and other price stabilization schemes are other often advocated policy tools. However, their effect on aggregate welfare and their distributional consequences are still open to a debate which requires empirical answers. As previously discussed, one can build theoretical models where everything is possible.17 Advocating them now to deal with risk problems seems to be quite ahead of our knowledge.

Another risk specific policy is plant protection by groups of farmers and government support of individual plant protection measures by information and other methods. The experiment in Central America reported by Carlson will help understand more clearly the feasibility of such approaches in developing countries. However, it is likely that such group actions will be confined to areas with a high concentration of very susceptible cash crops, such as cotton.

Another example is the introduction of new varieties into entire areas rather than leaving adoption up to individual farmers. Introducing varieties of different levels of maturity on a few farms only often increases risks of pests and birds for the newly introduced or the traditional varieties, or both. Areawise, introduction of varieties spreads and minimizes these risks. India is experimenting with this approach on a large scale.

Flood protection by the building of dams and other disaster protection or warning systems are also risk specific policies in which the analytical tools of decision making under uncertainty are surely most appropriately used to guide policy decisions.

Plant breeding decisions definitely have to take farmers' attitudes towards risk into account, especially if it should turn out that risk aversion is high. It is, therefore, important to quickly get a better understanding of possible tradeoffs between stability and yields.

16In the Indian subcontinent, where such relief measures are most important, the debates usually revolve around whether the relief is really reaching the worst affected areas or groups and how to improve the efficiency impact of public works undertaken in famine situations (see Jodha, 1975). Morris David Morris has added a new dimension by arguing that in India drought-prone areas receive relief so frequently that farmers choose too risky crop mixes and input levels relative to the expected profit-maximizing levels, thus, resulting in another inefficiency. However, if farmers are risk averse, there is probably little reason to fear such overshooting.

17See Newbery (1976).
To the extent that one believes that risk-specific policies are effective means of achieving the ultimate efficiency and equity goals, the investment of scarce economic research resources into questions related to these policies is surely warranted. Even in the case of crop insurance, more research may be useful. The main reason for disenchantment with insurance schemes is the excessive cost of writing policies and assessment of losses in individual fields. V.M. Dandekar for India has recently revived a suggestion to provide insurance where the indemnity payment does not depend on the loss in an individual field but is based on the shortfall from their normal levels of average yield across farms in a homogenous crop growth zone. This would enormously reduce administrative costs and overcome the moral hazard problem. Economists usually insist on the superiority of insurance over all other forms of risk dispersal, and research on such area-based insurance schemes may be highly fruitful.

As matters stand at present, with respect to adoption of new technology, we are left with few policy handles. Especially for overcoming a possible permanent discrepancy in fertilizer applications from an expected profit-maximizing level, no risk specific policy seems to exist, except making fertilizer responsive varieties more stable genetically, which has become a major breeding goal in many national and international breeding efforts.18

This leaves us with policies which are not specific to risk, but whose primary goals of growth or equity are achieved more directly. However, these policies usually influence the general risk situation of their target groups, either by increasing income levels of the recipients or reducing exposure to risks in areas other than agricultural production or both. It is clear that any increase in income or any reduction in risk in areas other than agricultural production (say, reduction of health risk) should increase the ability of the recipients to bear production risks and therefore allow them to choose production activities which are closer to maximizing expected returns. This is what Michael Lipton called (see Chapter 18), the reduction of background risks, although he primarily had in mind the policies specifically mentioned under that heading. Of course, how strongly the reduction of health risk affects the production decision of risk-averting farmers is an empirical question which has not been investigated so far.

On the whole, for all the policies which are not risk specific, it will, at this stage, be difficult to explicitly incorporate secondary risk reduction effects into a policy analysis framework. This is primarily because quantitative knowledge on side benefits in terms of risk reduction is simply nonexistent for most of these policy tools. Furthermore, such empirical knowledge will be difficult to generate and as long as the basic controversies in the risk area are not settled,

18Roumasset's "irrelevance of risk aversion" statements stem as much from his evidence that fertilizer does not increase risk in irrigated rice as from his despair of lack of direct policy handles to deal with any potential risk problem.
concentrating research on this aspect may be a misallocation of professional capacity. This, to some extent, disagrees with the position of Michael Lipton who would like us to take such risk-reducing effects explicitly into account in cost-benefit analysis.

In many instances, however, the side benefit of risk reduction might be investigated in a somewhat ad hoc manner by considering whether or not there is a conflict between the primary goal of these policies and the subsidiary goal of risk reduction. In the case of irrigation investment, both the increased production levels and the risk reduction will benefit the same target groups of farmers or regions and no goal conflict arises. This may be the case for many other policies as well. Therefore, rates of returns to all irrigation investments would be higher than those measured by increases in expected output. The addition of benefits would be the largest in those regions with the highest weather instability. Furthermore, irrigation investments, as a class, are likely to have higher risk-reducing side benefits than, say, road construction. Such unrefined knowledge might be sufficient to help choose among investment strategies when simple rates of return calculations without risk reduction benefits are unable to force a clear choice.

5. CONCLUSIONS

The inability of the conference to reach conclusions on the role of risk and uncertainty in many development problems and to formulate policies to deal with any possible adverse consequences of risk aversion stems primarily from three causes. First is the scarcity of empirical evidence on probability distributions of the decisions which are considered in the context of a particular development problem. Progress in this area will be slow and requires painstaking and often unrewarding empirical inquiries at the farm level. Second, the evidence on attitudes towards risk of development actors may be better but is still sufficiently scarce and shaky to allow few generalizations. Third, it appears that there are very few risk-specific policy alternatives with which to deal directly with possible adverse consequences of risk aversion, and on some of the obvious risk-specific policies such as price stabilization, much more evidence is needed before one can really recommend them.

Given this state of knowledge and the complexity of the issue, the problem area of this volume will, for some time, remain a specialized research area for a limited number of people. Decision theory under uncertainty can start to make an impact on development policy and development only if these researchers are able to improve the empirical knowledge in the area and to further simplify and standardize the methodological tools used to acquire empirical knowledge.
Chapter 21

Directions for research on economic uncertainty

Richard H. Day

To the list of substantial contributions already presented in this volume, I want to propose three topics for future research emphasis. These are (1) the characterization of stochastic variables, such as field crop yields and climatic variables, and their interrelationships; (2) improved models of economic behavior under uncertainty; and (3) the dynamic implications of risk and uncertainty. I will consider these briefly in turn.

1. STOCHASTIC VARIABLES

Empirical evidence suggests (1) that field crop yields exhibit frequency distributions that are often nonnormal in character and with pronounced variations in skewness and kurtosis; (2) that these distributions, or what is the same thing, their moments — including the high order moments indicating variance, skewness and kurtosis — appear to depend in a striking fashion on agronomic variables such as the amount of nitrogen added to the soil (Day, 1965).¹

The first of these facts implies that risk cannot be measured by any one moment of a frequency distribution: it has several attributes — or one could say just as well, there are several different types of risk — perhaps as many types as there are types of frequency distribution. If one insists on reducing risk to a single index, then one must ignore its multiattribute nature. For these

¹See Roumasset's introductory comments on estimating probability distributions (Ch. 1) and Just and Pope's contribution (Ch. 10) to this volume.
reasons, the Anderson-Dillon view concerning using empirical frequency distributions in expected utility models seems to be a reasonable one. Four parameter continuous systems, such as the Pearson system (Jeffreys, 1961; Elderton, 1938), may provide convenient and sufficiently rich approximations for this purpose.

The second fact illustrates the dependence of environment on decision making, an attribute of adaptive systems beginning to receive increasing attention (Bellman, 1961; Day and Groves, 1975). In the present example, the farmer, when he applies fertilizer, changes in a complex way the structure of prospects against which he is gambling. The implications of this are that Bayesian decision models (Fel'dbaum, 1965) are greatly complicated, so much so that one may wonder at their usability in either prescriptive or descriptive work in this setting.

Nonetheless, if decision-making models are to be based on probability distributions, then a better understanding of distribution characteristics in specific real situations would deserve much greater attention than it has received. Along this line, the results referred to above stimulated the question, “Why should field crop yields have such nonnormal distributions?” One hypothesis that occurred to me was that underlying weather variables had nonnormal distributions and field crop yields simply reflected them. Another was that while weather variables could be more or less normal, the photosynthetic process of plant growth involves a nonlinear transformation of stochastic inputs leading to nonnormality in the variation of plant outputs in a manner analogous to the lognormal transformation. To get at these hypotheses, data on water availability, temperature, evapotranspiration, and other factors of plant growth have to be incorporated into the yield response function. But the manner in which this should be done forces one to consider the dynamics of plant growth, which involves the time distribution of inputs in interaction with critical periods in a plant’s development. R.A. Fisher (1920) initiated such an investigation years ago and a small body of literature exists using his methods. The modern investigator may wish to reinstitute work of this kind.

Its utility might come in eventually making possible the derivation of stochastic production functions from underlying agronomic structures that would identify and measure the microcomponents of yield. If that were so, then one might be able to take prolific experimental data from one part of the world, estimate an agronomic yield function, and apply this function to another part of the world lacking abundant experimentation but with measurements available on the agronomic input variables. Certainly, at a minimum, we would acquire a better understanding of how probabilities should be represented in decision models in agricultural economics.
2. MODELS OF DECISION AND BEHAVIOR

From the above considerations, it seems evident that the theory of optimal economic decision must accommodate (1) the multiattribute nature of risk and (2) the interaction between the stochastic environment and the actions of the decision maker, in addition to aspects of the problems usually considered. This more adequate theory would presumably be used (1) to provide advice for farmers or (2) as a basis for government decisions. These applications presume an ability to derive estimates of all the parameters of the decision models involved and to compute solutions to the implied optimization problems. It is a fact that neither of these requirements are easily met.

But policy formulation need not be based on the theory and practice of optimal economic decisions to be effective. Instead, it can be based on an understanding of actual economic behavior, for on such an understanding can be based a prediction of the effects of changes in policy instruments. It should, in principle, be easier to provide knowledge about how people behave than how they should best decide. Nonetheless, our knowledge is too limited, in part, possibly, because of a mistaken notion that description cannot lead to theory, but only a senseless pile of individual facts. It is time to cast off this particular neoclassical blinder and gather into the mainstream of economic research methods and principles of behavioral economics based on observations, interviews, and introspection initiated by Simon, Cyert, March and Forrester.²

It is mistakenly thought by most economists that basing economic theory on empirical description is ad hoc — that proper theory must be based on the pure concepts of optimality and equilibrium. The prevailing fashion — which also dominates in the present group — is to derive equations that describe behavior from hypotheses based on the economic rationality of individual decision making and the efficiency of market exchange and then to estimate the parameters from quantitative data. Pure theory comes first, then comes empirical estimation and validation. The problem with this approach is that the hypotheses have no compelling empirical base on their own.

The manner in which careful observation and description can lead to new theory is nowhere better exemplified than in the works of the ethologists, such as Tinbergen (1951), or Lorenz and Leyhausen (1973). It should be possible to make great strides in the study of economic behavior as well as in the study of animal behavior using analogous methods appropriately tailored to the human, economic arena. I make no claim for having launched such a study myself, but my contribution to the present volume³ was offered in the spirit of this ethological approach, the view there being that the concepts of “danger distance” and of “flexibility of response” are directly experienced, empirically based concepts whose attributes can be studied by observation, introspection.

² Simon (1957a), Cyert and March (1963), Forrester (1961).
³ “Cautious suboptimizing”, Ch. 6.
and interview, possibly more easily than can the concept of probability which requires an order of intellectual sophistication less typical of farmers and businessmen than of gamblers and decision theorists, who as a matter of fact, have been and still are divided into warring camps of frequentists, fiducialists, and Bayesians.

My danger metric could, of course, be introduced into an objective function to be maximized or minimized as well as into the constraint structure — indeed, my theory incorporates a lexical ordering in which danger appears at one stage in the objective function, at another in the constraints. But in its latter form, it has an appeal shared by other safety-first and focus-loss modeling concepts, namely, that to incorporate risk into the constraints restricts the alternatives among which one has to search which simplifies the choice problem. Contrastingly, when introduced into the utility function, risk complicates the objective to be maximized (or minimized) like an earthquake bending and folding a sloping plain into a contortion of mountains and valleys thereby greatly complicating the search for the high points. From the behavioral point of view, then, it would seem highly desirable to consider feasibility restrictions as a means of accommodating risk within models of economic behavior. This corresponds, I argued in my paper, with actual decision-making practice.

Behavioral models have an advantage over competitors based on a priori concepts of optimality when and if, as I suggest is possible, their assumptions can be based on systematic observation and description of behavior. Their results have a compelling quality even when the econometric techniques for parameter estimation and model validation are crude or ad hoc in nature. By considering the structure of actual decision making, as is done in behavioral economics, it also becomes evident that potential behavior, behavior compatible with decision making and acting structures, is far richer than manifest behavior. Consequently, econometric techniques that infer structure from a history of past acts must, in principle, limit possible predictions about future behavior in a dramatic way. This is why econometric models so seldom seem able to predict surprises. This situation is analogous to our experience with human relationships. We predict most people's behavior on what they have done in the past. But some of them surprise us. Yet, we know quite well that the few individuals of whom we acquire an intimate understanding through long and deep conversation and argument are capable of drastic changes in mood, thought, and act including deeds unobserved so far. Analogously, models that base hypotheses of behavior on direct investigation of decision-making structures, such as the cautious optimizing approach, are quite capable of predicting catastrophic changes in behavior such as the conversion of explosive exponential growth into implosive exponential decay, an example of which is given in a dual-sector development model incorporating cautious optimizing in the form of flexibility constraints (Fan and Day, forthcoming) admittedly and necessarily at the cost of having no historical evidence on which to base the prediction of surprise.
Directions for research

All of this brings us to the third of the areas in which I should like to see greater research emphasis, namely, dynamic aspects of risk and uncertainty.

3. DYNAMIC IMPLICATIONS OF RISK AND UNCERTAINTY

A question that comes up repeatedly in the literature is, “How does the presence of risk and the farmer’s response to it influence economic development?” Without the benefit of dynamic analysis or historical investigation, it is often assumed or, when it is not assumed, it is found using static models, that the answer is, development is retarded or prevented.\(^4\) I want to make two points in this connection that suggest important areas for further investigation. (1) Unpredicted feedback and stochastic variation in payoffs cause bankruptcy which reallocates resources among decision makers. The intertemporal effects of such reallocations may or may not be cumulative. Whether they are determines if economic evolution will eventually generate optimal behavior, a question discussed first by Alchian (1950) and later with great insight by Winter (1964) who showed that the answer is not invariably yes. Nonetheless, the forced reallocation of resources because of stochastic events is a form of change that could accelerate development beyond what it might be if the statistically expected value for a system were always attained.

I suspect that the existence of deviations that cause mistakes in resource allocation in agriculture may indeed accelerate the process of change. Every time a mistake is made, you have a chance that someone will exceed the disaster level — that means bankruptcy. Every time you have a bankruptcy, resources are reallocated. They are taken away from somebody and given to somebody else. In a society where there is a desire to retain land and to remain in farming at all costs, this might well cause acceleration in change no matter how cautious decision makers are.

(2) Cautious behavior that gives the appearance of slow change or stationarity can in fact cumulate — even without bankruptcy and even in nonstochastic but complex nonlinear environments — into striking, even catastrophic change over intervals that may be long in an individual’s lifespan but are short with respect to the lifetime of the economy or civilization of which he is a part. In our empirical models of production, investment and technological change (Day and Cigno, 1978; Day and Singh, 1977), the prevailing mode of production may change completely in 10 to 20 years. Short-run caution is compatible with “long-run” radical change and, as a consequence, the “long-run” often generates unanticipated developments with often drastic consequences.

\(^4\)See Bliss (1976) and Roumasset (Chapter 6 in this volume) for some cogent observations on this point.
The inability to perceive such dynamic phenomena seems almost bizarre when one takes advantage of the perspective of hindsight. For example, in the midst of one of the world's fastest and greatest rural to urban migrations that occurred in the American South, agricultural economists advocated moving resources (people) out of agriculture (cf. Day, 1967). The same dramatic facts and the same myopic prognosis are being repeated in LDC's today. These examples show us that, far from preventing development, cautious behavior in the face of risk typical of farmers everywhere may be quite compatible with epic transformation.

How do you accommodate an allowance for the risk of consequences that may be accumulated over a long period of time, even when one is making properly cautious decisions? A possible direction in which one may look for an answer is Koopmans' (1964) idea of a flexible asset. Koopmans was looking into an alternative to modeling an individual with preferences over an infinite horizon. He observed that people really do not have preferences over an infinite horizon or even over a lifetime. They have a preference about what they may do now in relation to flexible situations from which they can do many different things in the future when the time comes. He gave the example of educational decisions. Very often, people will begin saving for their children's education without having the foggiest notion what school they will attend, what textbooks they will buy, or what the tuition will be. Preferences among these myriad future possibilities are not even formed. Yet, they are accommodated implicitly by providing flexible assets, usually in the form of some kind of financial reserve, that enables the appropriate inputs to the educational program to be purchased on the basis of preferences that are formed when the time comes.

This concept of flexibility seems to be immensely important when we look at the evolutionary consequences of episodic developments. We seem to observe a tendency toward growing technical efficiency with respect to relatively slowly changing or apparently stable states: growing specialization, improving cost efficiency. Our rational processes of thought lead us to incorporate what we know about the world and, on this understanding, to deal with it in the best possible way and this very often leads to specialization even when perceived uncertainties are accommodated. But the world keeps surprising us, revealing new aspects of its structure, new manifestations of its manifold possibilities.

I am talking now, not just about variability in payoffs from a stationary environment, the concept of risk that dominates the theoretical literature, but the kind of risk that comes from the accumulated effects of a sequence of cautious decisions based on a misspecified environmental transition structure. From this point of view, the basic goal of decision making might be to maximize robustness of decision strategies with respect to the most widely specified environments we can think of.
Humans are so far as we know the most flexible of living things, capable of survival in the widest of environments and of manipulating the environment in the widest variety of ways. Yet risky decision-making as it actually occurs may be compatible with evolutions toward specialization, technical efficiency and efficient resource exploitation that could in the long run threaten survival for man as surely as did the slow evolution over countless millennia of dinosaurs threaten with extinction the entire reptile phylum. Whether this possibility matters is, of course, not entirely a question of risk but also one of time preference, of values concerning the future of our species, and of the imperfectly understood nature of environmental transition. But to those to whom it does matter — because of their time preference, their values, understanding the way people really behave under perceived risk, and understanding the dynamic implications of that behavior for growth and development are first crucial steps in forming an understanding about what the full range of risks are that threaten economic agents now and in the future. Only after these steps are taken can a satisfactory theory of optimal decision-making be developed.
References


Ames, G. C. W., 1974. Who benefits from credit programs and who repays?, mimeographed, Department of Agricultural Economics, Georgia University.


References


Bell, D. E., 1975a, A utility function for time streams having interperiod dependencies, International Institute for Applied Systems Analysis (RR 75-22), Laxenburg, Austria.


References


References


CIMMYT (International Maize and Wheat Improvement Center), 1972, CIMMYT Annual Report.


References


De Janvry, A., 1972a, *Optimal levels of fertilization under risk: The potential for corn and wheat fertilization under alternative price policies in Argentina*, *American Journal of Agricultural Economics*, 54(1), pp. 1-10


References


Erven, B. and N. Rask, 1971, *Credit infusion as small farmer development strategy*, Ohio University, DAERS, Occ. paper no. 48.


References


References


Hargreaves, G. H., 1973, Monthly Precipitation Probabilities for Northeast Brazil, Department of Agricultural and Irrigation Engineering (Logan: Utah State University).


Haskell, E. S., 1918, A farm-management survey in Brooks County, Georgia, USDA Bulletin, no. 648, pp. 1-59.

Hatch, J. K., 1974, The corn farmers of Motupe, Ph.D. dissertation, Land Tenure Center, University of Wisconsin.


References


International Rice Research Institute, 1974, *The IRRI Reporter*, no. 2.


References


Johnson, G. L., 1970. The role of the university and its economists in economic development, presented as the J.S. McLean Visiting Professor Lecture, University of Guelph.


Johnson, G. L. and C. B. Haver, 1953, Decision making principles in farm management, Agricultural Experiment Station Bulletin, no. 593, University of Kentucky.


Katona, G., 1975, Psychological Economics (New York: Elsevier Scientific Pub.).

Kautsky, K., 1899. Die Agrarfrage, Dietz (Stuttgart).

References


Knight, F. H., 1921, Risk Uncertainty and Profit (Boston: Houghton Mifflin Co.).


References


References


References


Newsletter on Rural Financial Market Research and Policy, 1975, DAERS, Ohio University, Quarterly, no. 4.


Norman, D. W., 1974, *Rationalizing mixed cropping under indigenous conditions: The example of Northern Nigeria*, *Journal of Development Studies*, 11(1). (See also comment by Abulu, J., forthcoming in JDS)


Patrick, G. F. and J. J. C. Filho, 1975, *Low-income groups in Brazilian agriculture: A progress report*, Agricultural Experiment Station Bulletin, no. 79, Department of Agricultural Economics, Purdue University.


References


Raiffa, H., 1968, Decision Analysis (Reading: Addison-Wesley).

Raiffa, H., 1969, Preferences for Multi-attributed Alternatives (Santa Monica: Rand Corporation), RM-5868 DOT/RC.


Ramakrishna, K. T., 1974, Nationalized banks and neglected sectors, Asian Economic Review, 36(3).


Rask, N. and A. Reichert, 1972, Distributional problems of an expanding credit supply - The case of Southern Brazil, DAERS, Ohio University.


References

References


Sanders, J. T., 1922, Farm ownership and tenancy in the black prairie of Texas. USDA Bulletin, no. 1068, pp. 1-60.


Schluter, M. G. G., 1974, The interaction of credit and uncertainty in determining resource allocation and income on small farms, Surat District, India. OCC, paper no. 68, Employment and Income Distribution Project, Department of Agricultural Economics, Cornell University.


References


Shilomowitz, R., 1975, *The transition from slave to freedman labor arrangements in southern agriculture, 1865-1870*, mimeographed, University of Chicago.


References


Stark, O., 1975. *Utility, technological change, surplus and risk: The microeconomics of rural-to-
urban migration of labor in less developed economies*. Ph.D. dissertation, University of Sussex.

Stewart, J. P., 1961. *Farm operating capital as a constraint: A problem on the application of linear
programming*. Farm Economist, 9(10), pp. 463-471.

Stiglitz, J. E., 1972. *Some aspects of the pure theory of corporate finance: Bankruptcies and

64(2), pp. 851-866.

Stiglitz, J. E., 1974b. *Incentives and risk sharing in sharecropping*. Review of Economic Studies,
41(2), pp. 219-256.

mimeographed, Oxford University.

Stiglitz, J. E., 1974b. *Incentives and risk sharing in sharecropping*. Review of Economic Studies,
41(2), pp. 219-256.


Ohio University.

array of environments*. International Experiment Station Research Bulletin, no. 251, University
of Nebraska, Lincoln.

Sutiño and K. A. Gomez, 1968. *Analysis of experimental data from several locations and seasons*.

Tadros, M. E. and G. L. Casler, 1969. *A game theoretic model of farm planning under

and agricultural firms with the rural QP 360 quadratic programming code*. AER Bulletin, no.
117, Department of Agricultural Economics Experiment Station, University of Illinois.

Farm Economics, 46, pp. 67-93.

(Amsterdam: North-Holland Publishing Co.).

Experiment Station Bulletin, No. 198, pp. 1-30.


Think, W. R., 1974. *Rural credit and income distribution in Colombia*, AID and Rice University,
Houston.

Thomas, W. L. Blakeslee, R. Leroy and N. Whittlesey, 1972. *Separable programming for
considering risk in farm planning*. American Journal of Agricultural Economics, 54(2), pp. 260-
266.

Thomson, K. J. and P. B. R. Hazell, 1972. *Reliability of using the mean absolute deviation to

Thornton, D. S., 1963. *Techniques of inquiry in the field of decision making*. Farm Economist,
10(2), pp. 71-84.
References


References


References


Welch, D. E., 1974, Relationship of regional agricultural planning to international agricultural research efforts, Department of Agricultural Economics, Kasetsart University, Bangkok.


White, T. K., 1975, Credit and agricultural development: Some observations on a Brazilian case, in Patrick, G. F., et al. (eds.), Small-Farm Agriculture: Studies in Developing Nations, Department of Agricultural Economics, Purdue University.


Wilcox, E. V., 1918, Lease contracts used in renting farms on shares. USDA Bulletin, no. 650, pp. 1-36.


Yoshida, S., 1975, Eco-physiology of rice, paper presented at the symposium on tropical and subtropical crops held at the Centro de Pesquisas do Cacau, Brazil.

Young, A., 1929, Travels in France (Cambrige: Cambridge University Press).


Zellner, A., 1971, An Introduction to Bayesian Inference in Econometrics (New York: John Wiley and Sons, Inc.).


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