ADVANCES IN AGRICULTURAL ECONOMIC HISTORY

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INTRODUCTION

Issues surrounding agriculture have always had pride of place among academic research in economic history. Interest in agricultural issues does not seem to come into fashion, and then fade into the background only to return years later. Indeed, agriculture was so vital to the workings of historical economies that a steady stream of important scholarship continues to be produced.

Beyond its importance of being a record of the past, it is clear that much of the research in this area has important policy implications for both developed and developing countries. This type of work highlights an important facet of doing such historical research: learning from the past so as to understand better the world today. Several articles contained in volume two of *Advances in Agricultural Economic History* either implicitly or explicitly have lessons or policy implications for today.

Volume two of *AAEH*, like volume one, contains important new work by both established and young academics. Additionally, this recent volume reflects, both geographically and methodologically, the broad scope of cutting edge work being done in this area. It is this type of scholarship that we seek to publish in future issues. We invite scholars who work in all areas of agricultural history to submit their work for publication in future volumes of *AAEH*.

Kyle D. Kauffman
Editor

GREAT DISAPPOINTMENTS: THE LESSONS FROM NINETEENTH CENTURY TRANSITIONS FROM SLAVERY TO FREE LABOR

Stanley L. Engerman

I.

This paper will focus on a relatively narrow set of transitions in property rights in humans, with or without changes in political controls, in the nineteenth century, especially the decline and complete elimination of slavery in the Americas.[1] There was a shift from legally coerced labor to legally free labor, although with some variations and constraints in the timing of the emancipation and in the extent of freedom that was granted. The transition of property rights in people who now owned themselves after having previously been owned by others has led to numerous discussions and debates, both at the outset with concern about expected impacts, and subsequently in evaluating their consequences in historical perspective and attempting to reach some judgement as to whether and to what extent the transition was (or was not) a good thing.

As with other great reforms, the emancipation of the slaves in most parts of the world aroused high expectations, but ended with a major sense of disappointment about what had been accomplished. Expectations were high as to the expected effects upon not only the ex-slaves but also upon other members of society, who were also expected to gain. Disappointment was widely spread

Advances in Agricultural Economic History, Volume 2, pages 1–20.

ISBN: 0-7623-1001-4

among groups in society, since ex-slaves, ex-slave owners, and other members of society all believed that emancipation had failed to achieve most of its promised ends, and that considerably more remained to be done if society were to ever be able to receive the expected benefits. The different expectations, and times required to achieve the desired ends, meant that different short-term, as well as long-term, policies were desired by the different parties, pointing to a major difficulty in evaluating the response to emancipation. Nevertheless, the fact that few individuals seemed satisfied with the outcome of emancipation, suggests that perhaps the outcomes were mixed, with no one getting all they had hoped for, yet each getting some desired benefits.

II.

To better understand the transitions in the labor force institutions in the nineteenth century, it is useful to consider previous changes that have occurred in Western Europe and its colonies. The late eighteenth and the nineteenth century saw dramatic declines in those forced labor systems that had characterized previous developments in Europe's overseas colonies.[2] This did not mark the universal disappearence of slavery, since it continued to exist within Africa and Asia for several decades into the twentieth century.[3] Nor did it mean the ending of all forms of coerced labor even within Europe and its colonies, since there were continued shipments of convict labor to settle in Australia and other parts of the Pacific. The nineteenth century also saw the re-emergence of indentured labor in many parts of the world. Nevertheless, a large number of individuals had obtained some freedom, with an ability to relocate intra – as well as internationally. Most of the emancipations were accomplished with struggle and debate but, with the major exceptions of the United States and of Haiti, all were accomplished relatively peacefully, relying on political, not military, measures. Some transitions were more chaotic than others, based in part on the events in the years preceding emancipation or the initial difficulties of adjusting to the new system.

There were a number of different variations in the process of emancipation, based upon the changes in the ability to legally or quasi-legally control and influence the productivity of ex-slaves and in the allowances provided the former slaveowners (and serflords) as compensation, whether in the form of cash, bonds, or alloted labor time, and whether this compensation was paid for by the state and the taxpayers or by those previously enslaved or enserfed.[4] Legislation regarding access to land and other forms of labor influenced the ability to move and to seek new jobs, but in general these emancipations did add some flexibility to individual behavior in the economy. It was also

anticipated that a more effective labor input due to emancipation would have a favorable impact on the prospects for long-term economic development. Thus the transition was expected not only to lead to a new economic structure within society, but, as argued for in the legislation, it was believed that this would represent progress relative to the preceding condition, for both those freed and for others in the nation.

It should not be expected that the same legal changes would generate the same outcomes in all societies. The effects varied with, for example, the magnitude of the property value transferred, the relative importance of coerced labor in the total labor force, the relative importance of different agricultural crops and manufacturing outputs, the conditions of production for different commodities, and the internal and world market conditions in regard to different outputs, to point out the major economic variables, as well as with more general and social policies. Attitudes concerning differences in races and ethnicities involved in the emancipations also had an important impact on the range of transition possibilities. The economic conditions at the time of transition also had a significant impact on the nature of the adjustment to the new systems, with implications for the problems with the initial changes after emancipation. The ending of slavery in different parts of the New World took place when the systems were expanding economically, not declining, meaning that slavery's ending was more expensive, and its adherents less willing to see it end than earlier views of contemporaries and scholars had suggested. As indicated in the contemporary debates and, more importantly, by the rising trend in slave prices, slavery was expanding during the nineteenth-century, and was seemingly expected to continue into the indefinite future.[5]

This expansion reflected the increasing European and American demand for slave-produced commodities such as sugar, cotton, and coffee, the improved means of production made possible by the development of new methods and technologies of production, and also the transport developments that permitted the use of new, more fertile, soils. Thus the ending of slavery occurred at times of favorable economic conditions. This might be expected to provide for a smoother transition, although the prosperity under slavery would highlight any reductions in output that took place as a result of changing labor institutions.

III.

In no case, with the exception of Haiti, did the transition from slavery begin with a complete collapse of the social system, and in that case the collapse was due not to economic factors but rather to a massive slave uprising.[6] In all other cases the ending of slavery came by governmental decree or legislation. This

sometimes was due to, or enforced by, political change and military actions, as was the case with the ending of slavery in the United States as a result of the Civil War. In some cases the legislation followed rather quickly after successful revolutions, as was the case with some of the American nations when achieving independence from their European metropolis, as was the case with the northern states of the United States in the late eighteenth century and the several nations of South and Central America that gained their independence from Spain in the early nineteenth century. In only a few cases, none major, was there a widescale ending of a coerced labor system by a voluntary freeing of the laborers by their owners. The nature and terms of legislations for emancipating labor often differed, as did the form of legal actions taken to impose and enforce the changes, and this led to some differences in the ensuing transitions.

The legislation and political actions leading to the ending of systems of coerced labor, and the precise changes in the nature of property rights in laborers, as defined by nations, did not follow a uniform pattern. When labor was freed, their previous owners generally suffered a loss in wealth, due both to the ending of property rights in the surplus produced by slaves, and also because of the probable decline in land values with the fall in labor input.[7] In some cases compensation, in cash or bonds, was paid to owners, while in other cases the returns to the slaveowners were supplemented by a period of compelled labor or apprenticeship. In some examples of gradual emancipation, new-born children were considered legally free, but they were required to work for their mother's owner for a specified number of years. While slaves were nowhere given land or granted special terms for land acquisitions, the abolition of serfdom often provided the ex-serfs with rights to purchase land from their lords, at some legislated or agreed upon price.[8] The fact that ownership of land was frequently maintained by the former slaveowners indicates the limited nature of these reforms, and their attempt to maintain somewhat similar economic and political structures in the future.

IV.

Perhaps the most important economic benefit for the freed laborers resulting from the ending of coerced labor was the ability to move, both internally and externally, in response to economic and other forces, and the inability to be bought and sold.

Legal access to land ownership, which would limit the desire for mobility by the freed persons, varied with differences in the nature of legislation. There were no legal requirements or subsidized opportunities to acquire land from either the government or private landowners. Slaves could, of course, purchase

land on the same terms as other members of the population, as long as landowners were willing to sell to ex-slaves and the sale of government lands did not discriminate by race or prior legal status. It was this limited ability to acquire land that contributed to a highly mobile ex-slave population in many areas.

What the ending of coerced labor meant, particularly when there were also limits to land acquisition by ex-slaves, was that the landowners needed to learn how to deal in a labor market which entailed some degree of consensual bargaining with workers. No longer could force, coercion, or the purchase of labor be used either to acquire workers or to limit their departure from the working place. The need that arose to attract labor via bidding them away from others, with the use of incentives based on wages and other inducements, could lead to effects that no one hirer desired, such as higher wages and better working conditions for freed labor.[9]

Despite the dramatic nature of the changing labor institutions, emancipation often occurred with relatively limited political changes. The freed persons might not be given voting rights; indeed, many of the free people similarly lacked voting rights prior to the twentieth century. In other cases, such as the United States, the freed slaves were initially given voting rights, but over several decades there were effectively eliminated and were not reinstated for at least another half-century.[10] Similarly, in most societies, maldistributions of wealth persisted, often without there being dramatic changes in either direction. There may, however, have been some change in the identity of specific wealthholders, with a new elite replacing the previous one, and a different group of individuals obtaining political and economic power.[11] For the freed persons it perhaps made little difference who were the elite if any changes would not have influenced their conditions, and if their own landholdings remained limited. In most cases, however, power still resided within the same groups as before the start of the transition, and the failure to strip landowners of their major economic asset meant that their losses in wealth were no doubt limited. This should not be surprising, since with few exceptions, emancipation came from above, and those who introduced these changes were interested in limiting the magnitude of the changes they permitted.

It is important to consider that those societies in which emancipations occurred were tied into the world economy and its political system, and these relations with the rest of the world need not have changed in response to the localized changes in labor institutions. Many of the constraints influencing trade, capital, and labor flows, and international relations, remained as before. Being part of an ongoing market system, in both domestic and foreign matters, provided opportunities which were often taken advantage of, but it also set

constraints on the possibilities for economic and political changes. It is not certain whether the transition from slavery to agricultural peasantry gave rise to an expanded market orientation on the part of the laborers and the landowners than had existed before. What it did mean, however, is that while previously many consumption and labor allocation decisions had been made by owners, choices were up to the laborers who now confronted the need to make decisions that had previously been made for them.

V.

Emancipations of coerced labor were generally preceded by extended debates, political as well as among the general public, about what to do and how to go about accomplishing the desired ends.[12] The relatively democratic political systems in some nations meant that debates among the broad population or within the aristocracy were necessary concerning the proposed "progressive" reforms. These debates often took a rather long time, since reforms were seldom introduced immediately upon the emergence of social concern. Certainly the successes of British anti-slavery and United States abolition were not immediate, but were the products of decades of activity. There were few automatic or quick successes, and with the exceptions of Haiti, the Spanish-American mainland, and, ultimately the United States, few cases in which emancipation took place as the result of a rapid political change. Even in the latter two cases, however, the basic political and economic systems remained for the most part in place, since there were few major changes in political relations between rulers and lower classes. Political debate about emancipation generally concerned what measures should be introduced to put the proper institutions of the post-emancipation world into place, and what it was anticipated that new world would look like. While they were to free certain members of society, there was a professed belief that all would benefit, those freed as well as other members of society. The terms of the debate as to how the post-emancipation world would reform society included several separable issues. How much legal freedom should be allowed ex-slaves and at what pace? How long would it take the freed to be able to achieve real freedom and independence? To what extent should the state's authority be used to set and implement plans for the future? The role of the state could be an extension of the existing state apparatus or, as with the stipendiary magistrates in the British colonies and the Freedmen's Bureau in the United States, lead to the creation of new organizations.

Concerns with the future of the freed persons and the new society led to a number of variants in the changing property rights regimes, often with considerable differences in specific terms. The first major choice was whether

emancipation should be immediate or gradual, in the sense that its final granting was some time in the future. The primary argument for a gradual policy was that it would help ease the transition of the labor force (and their owners) to the new system, as well as lowering the costs of ending coerced labor. Apprenticeship periods lasted up to a decade, with that time presumably being used to help the laborers (and hirers) adjust to the needs of free labor markets. Another measure for gradual emancipation was to have all born after a given date be considered free, but required to work for their mother's owner for some period of time, often in the range of 18 to 25 years, thus having the slave's production when older compensate the owner for the prior costs of rearing, without requiring taxpayer money.[13]

Perhaps the best indicator of the limited range of the reform intended by legally ending coerced labor can be seen in the financial arrangements involved. Although there had been occasional discussion of providing land to the freed persons to supplement their right to benefit from their own labor, this was not provided for in any major case, nor were the freed given cash or any other assets. The ex-slaves were free to purchase land, but this was without any subsidization or compensation for their past exploitation. Rather, what compensation there was, was paid to the slaveowners, either by states in form of cash or bonds, or by the slaves in form of extended labor input. In general, land owned by slaveowners was not confiscated by the state, leaving the basic control over production still with the former elite. Thus the freeing of labor did not necessarily lead to dramatic shifts in the economic power structure, although the particular nature of the changes did vary with the ratio of labor to land in different societies.[14]

Of fundamental concern in defining the terms of emancipation and in setting the plans for the transition were the beliefs about the capabilities of the freed to deal with the new situation.[15] If, for example, it was believed that, whether due to genetic or for sociological reasons, the slaves were basically "savages" and backward in behavior and belief, clearly more controls over the process of freedom and a greater period of time were regarded as necessary in order to obtain any long-term benefits. On the other hand, if the unfree laborers demonstrated abilities comparable to those already free, and had both the interest and the ability to negotiate and bargain in the economy and society more generally, then a lessened governmental role after emancipation would be possible. The discussions of the expected capabilities of the freed included consideration of both their conditions at the time of emancipation and also the opinions as to how long it might take for any necessary adjustments to occur. With more experience and education, it was asked, could the freed achieve equal accomplishments with other members of society, and be

able to attain full economic and political equality? And, given the opposition attitudes of the ruling elite, would the freed persons be able to achieve this desired adjustment despite the imposition of political and economic restraints? Would it be necessary for the state to prolong its aid to the freed and to limit the actions of others in society? All of these questions needed to be considered when establishing the policies for the transitions after emancipation.

VI.

There is considerable information available about the economic changes with emancipation in those societies that had been based on slave labor. In many slave societies the principal crops, mainly sugar, but also cotton and coffee, were produced on plantations, with large numbers of workers, using a variant of a gang labor system. Gang labor had always been avoided by workers who had some choice of job and location. With emancipation, workers preferred, wherever possible, to leave plantation units using gang labor, and to work producing the same (if it could be done profitably without gangs) or different crops on smaller units.

As indicated by Table 1, those ex-slaves areas in which sugar production had been important suffered sharp declines in production, from which recovery took a long period of time. Declines in sugar production meant declines in income and export revenues, as indicated in the cases of Jamaica and British Guiana (see Table 2). Similarly, in the United States, emancipation meant a sharp decline in cotton production as well as in southern regional income, both of which took about two decades to recover (see Table 3). There were readjustments in production, with increased shares of foodstuffs produced in most areas, but it seems doubtful that these increased farm outputs offset the declines in plantation production.[16]

Thus, in general, emancipation led to declines in the number and sizes of plantations, with probable reductions in overall agricultural output. There were particularly sharp reductions in the production of export crops, with little development of a manufacturing sector or expansion in the production of other export crops. The effects on the material consumption of ex-slaves are not clear, given the varying effects of the changes in crops grown, the redistribution of the work forces involved, and our presently limited information of pre- and post-emancipation consumption patterns. The ending of slavery did however, often mean measured deterioration in health conditions and in life expectation.

Table 1(a). Average Annual Sugar Production Before and After Emancipation (000 tons).

	Five Years Before Abolition	Five Years After End of Restrictions[a]		Percentage Change	Period in Which Pre-Emancipation Level Regained
Haiti[b]	71.7		1.2	–98.3	1960s
Martinique	29.1	(1847)	20.05	–29.6	1857–1861
Guadeloupe	31.9	(1847)	17.7	–44.5	1868–1872
St. Croix	9.7[c]	(1848)	7.3	–24.7	c. 1890
Louisiana[d]	177.1	(1865)	44.0	–75.2	1887–1891
Surinam	15.7	(1873)	9.7	–38.2	1927–1931
Puerto Rico	94.0	(1876)	74.4	–20.9	1900–1904
Cuba	595.4	(1886)	745.7	+25.2	–
Brazil	254.0	(1888)	170.6	–32.8	1905–1909

Notes: [a] Date either of abolition or end of "apprenticeship" controls, except for Martinique and Guadeloupe, where emancipation occurred in April 1848; Louisiana, where it was the end of the Civil War; and Haiti (note b).

[b] The first column relates to the period ending 1791 The second column relates to the first years for which postrevolutionary data are shown (1818–1822).

[c] Output in 1840.

[d] Shown here are the averages for 1857–1861 (which includes the high output record for 1861, the highest of any antebellum year) and 1866–1870. The 1856–1860 average, which includes the very low output of 1856, was 132.4. If an additional two years were allowed for readjustment, the 1868–1872 average was 62.8, still a substantial decline for whatever combinations of years are chosen.

Table 1(b). Changes in Sugar Production in the British Slave Colonies Prior to and After Emancipation.

	(1) Percentage Change in Average Annual Sugar Production 1824–1833 to 1839–1846	(2) Period in Which Pre-Emancipation Level of Sugar Production Regained	(3) Ratio of Sugar Production in 1887–1896 to Sugar Production in 1839–1846
1. Antigua	+8.7	–	1.5
Barbados	+5.5	–	3 5
St. Kitts	+3.8	–	2.7[c]

Table 1(b). Continued.

		(1) Percentage Change in Average Annual Sugar Production 1824–1833 to 1839–1846	(2) Period in Which Pre-Emancipation Level of Sugar Production Regained	(3) Ratio of Sugar Production in 1887–1896 to Sugar Production in 1839–1846
2.	Trinidad	+21.7[a]	–	3.0[b]
	British Guiana	–43.0	1857–1866	3.4
	Mauritius	+54.3	–	3.1
3.	Dominica	–6.4	1847–1856	0.7
	St. Lucia	–21.8	1857–1866	1.7
	Nevis	–43.1	1867–1876	– [c]
	Montserrat	–43.7	1867–1876	2.5
	St. Vincent	–47.3	never	0.7
	Tobago	–47.5	–[b]	– [b]
	Jamaica	–51.2	1930s	0.6
	Grenada	–55.9	never	– [d]

Notes:

[a] Trinidad output did decline slightly after the end of the Apprenticeship and it was not until 1845 that the 1834 level was regained.

[b] Tobago data merged with Trinidad after 1891. The 1877–1886 level of sugar production in Tobago was two-thirds that of 1824–1833.

[c] Nevis data merged with St. Kitts after 1882.

[d] No sugar output shown after 1888 a year in which only 77 tons were recorded.

Source: Noel Deerr, *The History of Sugar* (London: Chapman and Hall, 1949–1950), pp. 112, 126, 131, 199–200, 212, 235, 236, 240, 250, and 377.

Measures of economic output were often used in debates as to the success or failure of emancipation. Even the abolitionists accepted this conceptual framework. Few initially argued that even with a fall in output, emancipation could still be regarded as a success, albeit now on moral, not economic, grounds. When post-emancipation output fell it was argued that the key to the problem of adjustment was the behavior of labor. Disagreements did persist as to the causes of the "labor problem," along rather predictable lines. To some it was the failure of the planters to behave properly toward their workers or to pay them adequate wages; to others it was due to the inherent characteristics of the workers, whose lack of desires for material goods and an unwillingness to labor led them to avoid plantation labor and/or production for the market.

Table 2. Population, Per Capita Income, Sugar Production, and Output Structure. Jamaica and British Guiana, post-1832.

Jamaica	Population (000)	Per Capita Income	Sugar Production (000 tons)	Share of Exports in Total Output
		(1910 prices)		(Current Prices)
1832	370.0[a]	£15.6	72	43.5%
1850	400.5[a]	12.2	29	24.3
1870	506.1	11.9	25	20.2
1890	639.5	12.4	17	19.1
1910	831.4	13.7	20	22.6
1930	1017.2[a]	15.7	65	19.8
British Guiana		(1913 prices)		(1913 prices)
1832	98.0	£23.9	55	43.3%
1852	127.7	19.9	49	22.8
1871	193.5	–	92	–
1891	270.9	–	114	–
1911	289.1	–	86	–

Note: [a] Computed by using Eisner's estimates of total product and per capita product.

Sources: The population estimates are for census years different from the year of output estimates in several cases, but these differ by only one or two years.

Col (l) Gisela Eisner, *Jamaica, 1830–1930* (Manchester: Manchester University Press. 1961), pp. 134, 289; Jay R. Mandle, *The Plantation Economy* (Philadelphia: Temple University Press, 1973). p. 19.

(2) Eisner, p. 289; Michael Moohr, "The Economic Impact of Slave Emancipation in British Guiana, 1832–1852," *Economic History Review*, *25* (November 1972), pp. 588–607; Mandle, p. 19.

(3) Deerr, *History of Sugar*, pp. 198–199, 203.

(4) Eisner, p. 237; Moohr, p. 589.

Table 3(a). Per Capita Income and Share of Exports in Agricultural Output, South, 1860–1900.

Year	Per Capita Income	Share of Exports in Agricultural Output	
	$	(a) Constant Prices	(b) Current Prices
1860	93.9	37.9%	–
1880	85.4	39.5%	51.7%
1900	116.1	–	48.4%

Source: See Engerman (1982).

Table 3(b). Changes in Output of Four Plantation Crops of the U.S. South, Before and After the Civil War.

	Average Output 1856–1860	Average Output 1867–1871	Period in Which Pre-Civil War Level Regained
Cotton (million lbs.)	1,720.2	1,323.6	1871–1875
Tobacco (million lbs.)	434.2	284.3	1877–1881
Rice (million Ibs.)	123.3	47.9	1882–1886
Sugar (million Ibs.)	132.4	54.4	1884–1888

Sources: See Engerman (1982).

VII.

Emancipation had an economic impact not just in the area in which freedom was granted, but also in other parts of the world influenced by trade patterns and labor flows. Reductions in sugar production in the British West Indian colonies not only provided a spur to Cuban production, but led to the development of sugar production in areas of new production such as Fiji, Australia, and Natal. More important, perhaps, was the increased flow of labor into the Caribbean from Asia and Africa, to provide the basis of a new plantation labor force and to permit increased sugar production. And, as Table 4 indicates, not only did labor flow to the Caribbean, but also to older sugar producing areas, such as Mauritius and Reunion, and to those areas newly producing sugar, where slavery had not previously existed.[17]

In regard to more general social and political changes, the patterns were more mixed. Advances in some dimensions were often matched by backward moves in others. The nature of changes varied over time, depending on the basis of the political controls, as well as the shifting distribution of property rights regarding land and legal controls over labor. In the case of the United States, for example, the freed people gained political rights to vote at the same time as many southern states passed restrictive labor regulations. Both of these changed over time, but the alternating pushes forward and ensuing setbacks meant that there would be a slow route to progress, with the pace dependent upon what was happening in other aspects of society. With such a prolonged period of changes, a specific legacy of slavery becomes hard to define, and the precise definition of the period of transition hard to isolate.

In other areas, the basic change in economic institutions occurred in the absence of political changes. For the British West Indian areas where slavery was ended, there was a lag of over one century between emancipation and the

Table 4. Estimates of Intercontinental Flows of Contract Labor, Gross Movements, Nineteenth and early Twentieth Centuries.

Areas of Origin to Receiving Region		Years	Numbers (thousands)
India to:			
	British Guiana	1838–1918	238.9
	Trinidad	1838–1918	143.9
	Other British Caribben	1838–1915	46.8
	Mauritius	1834–1910	451.8
	French Caribbean	1853–1885	about 79.7
	Reunion	1826–1882	86.9
	Surinam	1873–1916	34.0
	St. Croix	1862	0.4
	Fiji	1878–1917	61.0
	Natal	1860–1912	152.4
	Mombassa	1895–1922	39.5
	Malaya	1844–1910	249.8
China to:			
	British Guiana	1852–1879	13.5
	Trinidad	1852–1865	2.6
	Other British Caribbean	1852–1884	1.7
	Peru	1849–1874	about 90.0
	Cuba	1848–1874	124.8
	Hawaii	1865–1899	33.6
	Transvaal	1904–1907	63.7
Japan to:			
	Hawaii	1868–1899	65.0
	Peru	1898–1923	17.8
Java to:			
	Surinam	1890–1939	33.0
Portuguese Islands to:		1878–1899	10.8
	Hawaii		
	British Guiana	1835–1881	32.2
	Other British Caribbean	1835–1870	8.8
Pacific Islands to:			
	Australia	1863–1904	61.2
	Elsewhere in Pacific	1863–1914	about 40.0
	Peru	1862–1863	3.5
Africa to:			
	British Guiana	1834–1867	14.1
	Jamaica	1834–1867	11.4
	Trinidad	1834–1867	8.9
	Other British Caribbean	1834–1867	5.0
	French Caribbean	1854–1862	18.5
	Reunion	1848–1861	34.3

Table 4. Continued.

Areas of Origin to Receiving Region	Years	Numbers (thousands)
Yucatan to:		
Cuba	1849–1871	about 2.0
Angola to:		
Sao Tome and Principe	1876–1915	about 96.5

Note: Several intracontinental flows are included, those from India to Malaya, from Yucatan to Cuba, and from Angola to the offshore islands. Also. some relatively minor intercontinental flows of contract labor are omitted, in addition to movements within Africa in the late nineteenth and twentieth centuries. In a few cases there may be small amounts of noncontract labor included, and there may be some differences between numbers registered, numbers departing, and numbers arriving, but these will have only a rninor impact on the figures. The years are not in all cases calendar years. and the dates of flows are approximations in some cases, including years in which the trade was prohibited, but again these will not have any impact on the interpretations. Finally, there are a number of discrepancies among the various sources (compare, for example, the details of estimates for the Indian emigration in Ferenczi and Wilcox, *International Migrations*, with the estimated inflows given in others sources), but again these do not alter the basic pattems.

Sources: See Stanley L. Engerman, Contract Labor, Sugar, and Technology in the Nineteenth Century, *Journal of Economic History*, *43* (September, 1983) pp. 635–659.

granting of political independence, while even today the French Caribbean islands are part of France, and some of the Dutch islands remain part of their (rather shrunken) colonial empire. Elsewhere, as in Brazil, political independence preceded the ending of slavery, by some six-plus decades, as was the case with large lags, for the United States and with varying lags for Spanish-America. The 1889 coup in Brazil, one year after slave emancipation, may, however, have had some relation to the abolition of slavery, but as effect, not cause.[18] In the United States a war between North and South was needed to end slavery. In most cases, however, ending slavery had more limited political impacts.

VIII.

In the southern U.S., ex-slaves remained within the agricultural sector, generally still growing cotton, but now producing on small, family-operated units or else working as laborers on small farms owned by whites. Aggregate cotton output was maintained in the late nineteenth century by the movement of whites into the production of cotton throughout the South. White families generally worked

on owner-operated farms. The lower measured efficiency of smaller farms led to a decline in overall southern agricultural output for several decades, higher costs, and a temporary loss of the near monopoly position of the U.S. South with respect to the world cotton production.[19]

The nature of the economic and political adjustments made within the South were not uniform over time, there being several dramatic shifts within the first three or four decades after emancipation.[20] Blacks were granted, legally, the same citizenship and voting rights as whites in the immediate aftermath of the Civil War. Black political voting and the election of black officials persisted for several decades, until ended by state legislation in the 1890s.[21] Education of ex-slaves, on the basis of private and public expenditures, expanded after the war, albeit with smaller amounts spent than for whites, but with an extended decline after the loss of voting rights in the 1890s.[22] Further the 1890s saw a large number of laws and regulations in the southern states regarding black occupation, residences, and public discrimination, in addition to a sharp increase in the lynching of blacks.[23] Thus it took about one-quarter century after the Civil War to the full extent of southern regulation and racism to become legally secure.

An important explanation of the changes in the 1890s is the sharp decline in the world cotton market in that period, influencing whites as well as blacks, landowners as well as sharecroppers. This cotton crisis had an impact throughout southern political and economic life, and led to a more pronounced racism then in the earlier periods. Nevertheless by focusing on this decade of poor southern economic performance, a number of quite significant changes after the end of slavery are sometimes overlooked. Since at least 1880, if not 1870, the southern economy was growing about as rapidly as was the North, in the years of rapid northern industrialization. The regional inequality of per capita income continued until about 1940, after which southern per capita income levels began to converge on that of the North. The ex-slaves were able to achieve some degree of economic progress, with increasing wealth, with land ownership, and bank deposits. While they suffered from severe economic problems, their precise nature is often misunderstood, and their causes different from often argued. While interest rates charged by merchants on credit sales (and presumably with an equivalent high charge for cash sales) must have exceeded the rate of large, collateralized loans in northern financial centers, the difference, if any, compared to small, personal, uncollateralized loans such as in the south, was much smaller, if today's markets provide any relevant comparison.[24] Given the conflicts of landowners and merchants, often legally resolved at the state level in favor of landowners, it is doubtful that the merchants were in a monopoly position, a conclusion consistent with the inability of merchants to accumulate large

amounts of wealth.[25] To understand the circumstances generating high interest rates in the South it is important to consider the southern shortfall in capital after the War, and the high cost of capital to that region and its entire population at the time.

Thus, the material economic and political gains to ex-slaves in the U.S. South exceeded those elsewhere in the Americas, and even after the changes in the 1890s, the economic circumstances were, in material terms, still better. Yet these gains were not as substantial as those expected by those advocating the end of slavery, and whether a legacy of slavery or the response to the post-slave period, the early optimism and hoped for large scale improvements did not occur.

IX.

Despite the great surge of accomplishment and optimism that occurred with most emancipations, relatively soon afterwards there often emerged a sense of disappointment regarding the outcomes of these transitions. This, of course, may have been no different than the reactions to most other economic and social changes. After emancipation, a belief soon emerged that things had not turned out as hoped, that progress was too slow, and, whether the political system was regarded as democratic or not, that the nature of conflicting individual interests often meant quite messy and complex occurrences.

Clearly, based on this long history, any sense of disappointment in our present-day examples of transitions in Eastern Europe is not unusual, the same feelings having existed for many earlier cases. Change has always tended to be slow as well as reversible, and the equality desired impossible to achieve. Not all steps in the process of transition go in the preferred direction, and to achieve proper changes often takes considerable times. And, today, unlike in the past, there is much more immediate coverage of the problems and pitfalls, all brought to everyone's attention at once. Given a bias toward emphasizing the negative aspects of change, and the particular problems of delayed adjustment, the political course during the transition can now be quite difficult. While in the nineteenth century we had Parliamentary hearings and Congressional debates to present the negative aspects of those changes with the ending of slavery, this type of information seemed then to be diffused more slowly and to reach fewer people.

Why then have changes been so limited and so slow in response to major changes in labor institutions? First, dramatic changes in labor institutions generally occurred with only limited changes in the balance of political power, thus precluding any major opening up of the system. As noted, the Asian and Caribbean colonies of Britain did not achieve independence until after World

War II; in the United States blacks continued to face racism in a nation where political power remained with whites. It is also important to recognize that not all individuals and societies sought the same ends, and to many the relative benefits to be obtained from racism or from ethnic rivalry outweighed the benefits of a higher overall income for all.

Since each nation cannot be independent of the rest of the world, world economic conditions and conditions in other countries can limit the prospects for what might be considered a satisfactory adjustment. At various times the problems of the world cane sugar market due to the presence of too many producers, as well as to the development of beet sugar, meant that unless a rapid structural change took place, incomes of cane sugar producers could not expand rapidly. The difficulties in the world cotton market had a similar important influence on the United States transition in the 1890s. The success of manufacturing in Britain and elsewhere in Europe served to limit opportunities in other areas. Thus the changes in the world economy had significant, but at times perverse, effects upon economic growth and income distribution. Economic reality, with its limits on the amount that could be produced, with its recurrent cyclical fluctuations, and with the problems of market coordination, provided constraints on what could be accomplished by changing labor institutions alone. This need not mean that positive changes had not occurred. Even reasonable economic growth, if starting from a low level, may make it hard to appreciate the absolute changes that have occurred.

Unlike other debates about historical changes, few compare the post-emancipation adjustments with some variant of the "good old days," and argue that some retrogression had taken place. Nevertheless the claim of the absence of progress returns us to the comparisons of alternative labor forms and the question of whether slavery was unique in its effect upon people. Certain labor forms, such as convict labor, indentured labor, and debt peonage had preceded slavery in many parts of the world, and they were to succeed it when slavery was abolished. Indentured labor, the most important of these for transoceanic movements, can be regarded either as primarily voluntary, reflecting a choice made at low incomes, or else as coercive, "a new system of slavery" since working conditions, even after the initial contractual agreement, were harsh, individuals could be bought and sold, and labor mobility was limited.[26] Depending on which of these possible interpretations of indentured labor is accepted, the overall evaluation of the effects of slave emancipation and the nature of the ensuing sense of disappointment will differ. In the same manner, if low incomes, with or without legal coercion, are considered to be the outcome of exploitation and "wage slavery," disappointment with the outcome of emancipation would occur, similar to the disappointment with the outcomes in a free labor society which provide a similar result.

NOTES

1. Parts of this essay draw upon related materials published in Engerman (1999, 2000), attempting to place major institutional transitions in a broad context.

2. For a discussion and dating of these changes, see Engerman (1995). The endings of slavery in the Americas occurred at about the same time that serfdom was abolished throughout Eastern Europe, and many of the arguments about effects and expectations for the future were quite similar for these two types of forced labor. See Blum (1978).

3. For interesting descriptions of the long persistence and late ending of slavery in Africa and Asia, see Klein (1993) and Miers and Roberts (1988).

4. See Engerman (2002).

5. See, e.g. the discussion of slave price trends in Eltis (1987).

6. For discussions of Haiti, before and after emancipation, see Rotberg (1971), Fass (1988), and Fick (1990). One of the ironies (and tragedies) of independent Haiti in which the farmers avoided plantation production of sugar, was that in the twentieth century Haitians migrated, seasonally or permanently, to produce sugar on plantations elsewhere in the Caribbean.

7. See, for example, the discussions in Fogel and Engerman (1974), as well as Fogel (1989).

8. See Blum (1978), and for the perverse case of Russian land sales, see Domar (1989).

9. For this general argument, see Higgs (1977), who points to the crucial nature of the political system in influencing the economic conditions of the South. For an analysis of postbellum black migration, see Cohen (1991).

10. On the important change in legislation and other controls on black voting patterns, see Kousser (1974).

11. This is the basis of the debate started by C. Vann Woodward, (1951), which has long been one of the staples of southern postbellum history. For discussions of postbellum southern land ownership, see Shugg (1968) and McKenzie (1994).

12. For a recent examination of these issues, primarily in the British case, see Drescher (1999).

13. See Fogel and Engerman (1974) for a presentation of these arguments.

14. For an argument on the role of the land-labor ratio in influencing the rise of coerced labor, see Domar (1989), chapter 12. The argument is equally useful in describing the differing effects of emancipation given that most European powers introduced policies to achieve the same ends in all areas.

15. While the debates on the effect of slavery on the enslaved, raised by Elkins (1959), have continued, there seems less discussion linking the answer to the slavery questions to that of the nature of the emancipation process designed for the transitional period or even how long the transitional period was expected to continue.

16. This paragraph included material from Engerman (1982).

17. See Northrup (1995) for a detailed description of contract labor, its sources and its destinations and on the movement from China and India to the British West Indies, see Look Lai (1993).

18. For a discussion of this issue, see de Costa (1985).

19. See Ransom and Sutch (1977) and for a different perspective, Wright (1978).

20. For discussions of the initial gains, limited as they were, of ex-slaves in regards to land ownership and related matters, see Oubre (1978), Holt (1994), Kerr-Ritchie (1999), and Rabinowitz (1978). On Reconstruction more generally, see Foner (1988).
21. See Kousser (1974).
22. See Margo (1985) on black education and black wealth in the postbellum period. Even then, however, the literacy rate of blacks in the South, while considerably lower than for the whites, exceeded that in the other nations of the Americas.
23. On lynchings, see Tolnay and Beck (1995), Patterson (1998) and Williamson (1984).
24. Forthcoming work by Peter Coclanis will deal with the issue of the appropriate interest rate comparison.
25. On the merchant-landlord conflict, see Woodman (1995).
26. See the classic indictment by Tinker (1974).

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FREEHOLD TENURE IN LATE EIGHTEENTH CENTURY DENMARK

Ingrid Henriksen

ABSTRACT

In the wake of a major reform period, 1788–1807, Danish landlords voluntarily sold off about half of their agricultural land to their tenants and thus transformed tenure from primarily leasehold to a dominance of freehold. One explanation could be that nominal rents were rigid when grain prices boomed. Quantitative and qualitative evidence presented here suggests that real rents were in fact declining although there was a large surviving element of rents paid in kind. Moreover, it is demonstrated that tenants, despite their declining real payments, were equally interested in buying. Essentially, land sales represented a gain to both buyers and sellers. The main reason for this was the lingering of labor services, so-called boon works, as an important element of rent. According to a contemporary estimate, the landlords' benefit from this labour was one half and even sometimes one third of the tenant's opportunity cost. Hence boon works represented a major cause in the difference in efficiency between peasant production under leasehold and that under freehold.

1. INTRODUCTION

This paper is about a major reform in Danish agricultural tenurial practice in the period 1788–1807. Essentially, Danish landlords sold off about one half of

Advances in Agricultural Economic History, Volume 2, pages 21–39.

ISBN: 0-7623-1001-4

their agricultural land to their tenants. A survey of the circumstances of peasant emancipation elsewhere in Europe makes it clear that there was no such thing as a uniform process of agrarian modernization or identical outcomes (Rösener, 1994, p. 186). More specifically Milward and Saul (1973, p. 70) when comparing European systems of land management during the eighteenth century states that the growing external and internal trade in that period did not operate in a similar way on various societies. According to Smout (1987, p. 93) an apparently voluntary resignation by a landowning class of the social and economic power of Danish landlords has no European parallel.

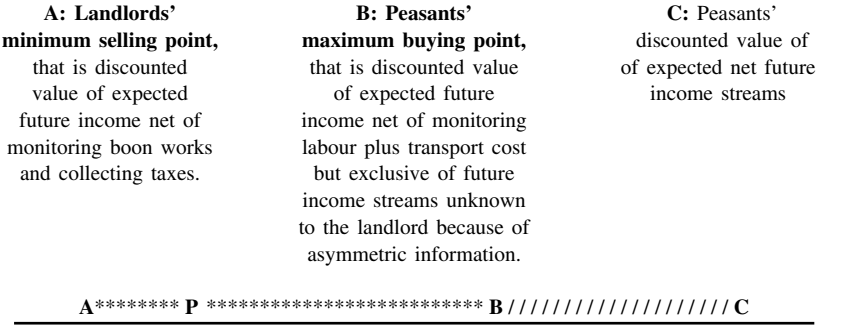
This paper will analyze the specific circumstances that transformed Danish agricultural tenure from primarily leasehold to a dominance of freehold. The traditional historiography has highlighted the surge in grain prices and the subsequent surge in the price of land as a major driving force. To the extent that land prices reflected the discounted value of future net income streams, landowners had no a priori interest in selling land. However, one explanation could be that nominal rents were rigid when grain prices boomed. Contrary to what has sometimes been claimed, quantitative and qualitative evidence presented here suggests that real rents[1] were declining although there was a large surviving element of rents in kind.[2]

Moreover, it will be demonstrated that tenants despite their declining real rents, were equally interested in buying. State protection in the form of leasehold for life put them in a strong bargaining position *vis-à-vis* the landlord. Consequently the exchange took place at prices below the market price.

It will, furthermore, be shown that landlords and tenants in Denmark differed in their valuation of peasant land. This was due mainly to the productivity advantages of farm servants working peasant land compared to servants performing boon works on manorial land. Finally, it will be argued that there was a net gain for both parties: the landlords and the tenant farmers.

To give a sense of the Danish land rental system on the eve of the land sales period, the paper begins with a qualitative and descriptive account. It is argued that the system generated a different valuation by landlords and tenants of the land leased to tenants. In Fig. 1 this is illustrated by the distance between the points A and B which depicts the landlord's minimum selling point, i.e. the lowest price accepted by the landlords respectively the peasants' maximum buying point, i.e. the highest bid made by the tenants. Section 3 will elaborate on the differential value of labor services. Section 4 provides quantitative evidence of the discrepancy between the actual selling price to tenants, P (within the interval A-B), and the market price of land. The latter is estimated as the price, C, when owner-occupiers resold their land. In Fig. 1 the placement of P indicates a bias in favor of the tenants as buyers of land. Section 5 explains this as a result of a

discriminatory land market. In Section 6 qualitative evidence of opportunistic behavior by tenants is supplied to account for the difference between B and C in Fig. 1. Finally, Section 7 looks into the landlords' alternative to leasing land.



***** The difference between the landlords' minimum selling point and the peasants' maximum buying point is determined by a **difference in efficiency** due to:
(1) the discrepancy in productivity when servants perform boon works on manorial farms compared to servants' work on peasant farms
(2) the landlords' cost of tax collection
(3) in a dynamic perspective: the higher efficiency of peasant land use because of concealed gains from improvements by the party who knows the potential of the particular farm best.

P The **actual price** at which land is sold to the tenant is determined by **the relative bargaining position** of the two parties. In this case it is biased in favour of the tenant.

//////// The effect of a **difference in information**, that is expected future income streams not revealed to the landlord. This determines the price at which the owner-occupier will resell his land.

Note that peasants and landlords are assumed to use the same rate of discount.

Fig. 1.

2. TENURE AND LAND RENT: REGIONAL VARIATIONS

Around 1700 the share of total land farmed by landowning peasants amounted to less than 1%. According to the first official account for the country as a whole, in 1835, almost 65% of the land[3] was by then owner-occupied, but as shown in Table 1 regional variation in tenancy was substantial.[4]

Table 1. Tenancy According to *Hartkorn* by Region 1835 (Percent).

Region	Manorial home farms	Freehold	Copyhold of inheritance	Leasehold for life	Towns	Total
Zealand	11.4	13.1	21.3	52.3	1.9	100
Funen	10.9	35.9	0.9	50.9	1.4	100
Lolland	13.5	20.0	8.4	55.5	2.6	100
Falster	8.1	35.2	2.9	52.6	1.2	100
Jutland	7.3	65.6	2.0	23.7	1.4	100
All Denmark	n.a.	65 (Freehold + Copyhold)		n.a.	n.a.	100

Source: Bjørn (1988, p. 26).

Only to a minor degree was the change a result of an upsurge in Crown land sales during 1764–1774. The interesting question is what motivated *private* landlords to sell in view of their indisputable right to command over their property?[5]

The period in which the major change in tenure took place can for various reasons be narrowed down to the years 1788 to 1807. This was a period of rising grain prices and subsequent rises in the price of land. The puzzle remains: why did so many landlords deliberately sell an asset that was expected to rise even further in price?[6]

Rent to the landowner was customarily paid in three parts:

(a) *Indfæstning* – an entry fine or purchase of the lease in cash that could be raised with land prices, but due to the leasehold for life could only be collected about every 20–25 years (each time there was a turnover).
(b) *Landgilde* – a rent in kind, primarily in grain, that had been fixed in absolute terms according to a provision in King Christian V's "Danish Law" which ran from 1683 until 1792. Towards the end of the century landgilde in some regions, particularly in Jutland, had been commuted to a money rent. The 1683 law specifically mentioned that landgilde paid in cash was also nominally fixed.
(c) *Hoveri* – boon works on the landlord's home farm, typically carried out by the tenant's live-in servant bringing a pair of horses, a carriage, or a plough for a number of days a year. Boon works had been commuted to a grain or a money rent in some regions.

It is sometimes implied in the writings of Danish historians that land rents under leasehold in Denmark mirrored land prices fairly well (Hansen, 1964, p. 89; Kjærgaard, 1980, p. 70). As might have been expected the scattered information

on flexible money *entry fines* shows an increase during the years considered here. Johansen's (1988, pp. 360–361) computation of a real increase (in 1800–prices) in entry fines on some farms on the island of Funen during 1780–1789 to 1800–1809 shows an acceleration from a growth of 1.6% per year to 2.6%. He puts it down to either improvements on the farms or a decrease in the land/labor ratio. Another possibility is that increasing entry fines, however small, was a way of making up for the de facto inability to adjust other margins in the contract.

A major part of the annual rent in most regions was still in kind until the latter third of the eighteenth century. These rents were paid as grain or other goods in the case of the *landgilde* or in *labor services*, so-called boon works.[7] Furthermore, labor services due by the tenants, at least until the late 1790s, were flexible and thus could be raised in response to booming markets. Consequently, both types of in kind rents would enable the landowners to capture Ricardian rents on land in the face of rising grain prices.[8]

To what extent did landlords utilize this opportunity? Statutory reports to the central administration on the size of labor services (measured in days with a pair of horses with or without a plough and in man days alone) from 1769 until 1795 is our main source of information. According to one estimate, the burden of labor services during that period almost doubled. However, there is doubt as to whether the landlords actually availed themselves to the number of days they were entitled to according to the contracts with their tenants. Some historians suggest that landlords may have safeguarded themselves by demanding, and reporting, more labor services than they perceived a need for. Although labor services were undoubtably raised, the reports and others sources may have exaggerated the increase.

Rents in labor services were, however, met by increasing difficulties, as Section 3 will show, which made way for a more flexible *landgilde*.

A royal decree, in 1792, tied adjustable money rent to the enclosure of tenant farms. The decree gave landowners the right to transfer the ensuing costs to the tenants and to renegotiate the (previously fixed landgilde) rent at the replacement of the tenant after the consolidation of the tenant's farm had been carried out. For farms that had already been enclosed in 1792, renegotiation could take place after the change of tenant. This has been regarded by some historians as the change of tide whereby one old system of flexible rents (in labor services) was replaced by a more modern system (in grain or most likely in money). In fact, neither system was flexible enough, as we will demonstrate.

This short description of the rental system has illustrated how it is almost impossible to calculate the development in rent in a straightforward way, e.g. by constructing an index based on the prices of labor and other elements of

rents in kind. Add to that the problem of assessing the extent to which the money commutations that had taken place actually mirrored the value of the former element of rent in kind and the issue becomes extremely complex. This was especially true of the so-called 'boon works money' as we will be see in Section 3.

An examination of the development of land rental markets can never be extended beyond the regional level since there were regional, and sometimes local, variations in the relative weight of the elements in the contracts. For instance, there was a marked regional pattern in the use of boon works. An estimate for 1770, reproduced in Table 2, tells us that commutation of boon works had gone furthest already at that time in Western Jutland while the Isles lagged behind. In Jutland in particular, boon works was often reduced to the obligation of supplying transport services such as a worker with a pair of horses and a carriage to bring the landlord's grain to town.

It may be tempting to compare this regional account of the rental system on the eve of the major land sales with the regional pattern in tenure afterwards (as seen in Table 1). There is some correlation of commuted rents and a high incidence of freeholders, especially in the case of Jutland. Is this indirect proof that in spite of what has been said increasing boon works was an option for landlords to maintain their share?

It is not that simple. The regional differences observed are the result of path dependence and of different resource endowments. Thus, the fact that boon work could be and would be increased is not in and of itself proof that it was well suited as a means to raise real rents. Rather, the heavy burden of labor services as well as the slow progress of land sales in some regions is closely interwoven with other local characteristics. This will become evident when we look at some features that distinguished the regions where labor services prevailed and where the process of land sales proceeded slowly.

Table 2. Tenants Doing Labor Services as a Percent of All Tenants by Region in 1770.

Region	Full labor services	Reduced	Free of labor services
North Jutland	61.0	15.8	23.2
West Jutland	43.5	36.6	19.9
East Jutland	58.7	25.0	16.3
Zealand	70	n.a.	n.a.
Lolland-Falster	n.a.	n.a.	10–12

Source: Skrubbeltrang (1941) pp. 21–22.

On the islands of Zealand and Lolland-Falster where a system of villeinage had existed from the late fifteenth century until 1702, large home (landlord) farms were associated with an extensive use of labor services compared to other elements of rent.[9] Also, relatively high population density which diminished transportation costs between tenant farm and home farm are correlated with a higher incidence of labor services. Thus, relative population densities were estimated to 2.3 on Zealand when it was 1 in Jutland. Certain aspects of soil quality furthered the use of labor services because they required more work, for instance, arable land rather than pasture and clay soil rather than light soil. Clay soil also entailed a brief 'critical' period during sowing and during harvest in which the work had to be carried out. This favored a system where a large group of workers could be deployed at short notice. Finally, fertile soil rather than poor soil acted as a brake to a more diversified and thereby a more monetarized economy. The latter would have facilitated a modernization of the rent system and led to a subsequent decline in the use of labor services.

Danish landlords living under these conditions adhered to boon works for a long time, particularly when compared to their Western European counterparts. The capital tied up in the home farm made many of them see no other short run option. The value of boon works on the home farm was capitalized in the price of their estate. In addition, the necessary reorganization of home farm production that would have enabled it to be run without the tenant's labor services took time and demanded various investments. These investment costs included the parceling out of small holdings, the building of cottages for farm laborers, and the procurement of horses and farm implements until now supplied by tenants.

To complicate the picture further when we look at rents in general and the role of boon works in particular it seems that boon work was sometimes utilized as an 'adjustment' to the other elements of rent in poor regions. From studies of individual estates we find that during the 1770s boon works was increased as a provisional hedge against losses on tenant's land. Tenant arrears accumulated during periods of successive bad harvests and cattle diseases in not only in the payment of rent, but also in the payment of royal taxes (for which the landlord was ultimately responsible). The request for some extra work from the tenants was often the only way for the landlord to curb his losses.

Landlords in the regions with the opposite characteristics to those mentioned, Western Jutland is a particularly good example, were also the first to sell their land. Their home farms were small and could be cultivated with little input of labor. Labor services had instead been commuted to a rent in grain or money early on.

This Section has demonstrated the difficulties involved in a calculation of real land rents. The only safe conclusion is that fixed money rents must have inflicted a loss on some landlords, we do not know the proportion of landowners affected nor the amount of their loss. Also, boon works, or labor services as a flexible element in the rent system, was hardly an optimal long term solution to the problem of preserving real rent. In the next sections we will therefore turn to other types of evidence.

3. DIFFERENCES IN EFFICIENCY: LANDLORD VERSUS PEASANT

A certain adjustment of rents in the form of boon works did take place, as we have seen. There were also fewer sales in the boon works regions for this and other reasons.

However, a very important countervailing factor in these regions was the different valuation by landlords and tenants of land leased to tenants. In most cases the tenant's servant was sent to the manorial home farm, with or without a pair of horses and agricultural implements, and did a whole day's field work supervised by the landlord's bailiff. It is illustrative when, according to Begtrup[10] (Sjelland et al., vol. I, 1803, p. 175), some landlords in Zealand, (Eastern Denmark), estimated their benefit from this labor that it came to one half or even one third of what it cost the tenant farmers. Even on the island of Funen where labor services seem to have been more expediently arranged than elsewhere, a landlord was heard complaining that "10 workers doing labor services did not achieve as much as 2 hired workers" (Falbe Hansen, 1889, p. 68).

No doubt the servant's immediate employer, the tenant farmer, was in a better position to monitor his servant if the latter worked on the tenant farm. To put it in a principal/agent framework the principal, the tenant farmer, was allowed considerably more control over his agent on his tenant farm. The costs from the point of view of the tenant was related not only to the waste of his servant's time, but also to the time and effort of his horses due to long rides from the tenant farm to the home farm. Reform politician and later chancellor of the exchequer count Reventlow, in a recommendation on boon works from 1788, comments on the well known observation that the exportable surplus of grain originates from the home farm production.

> But this grain . . . is produced at such costs to the peasant that the State, on the other hand, may have incurred a greater loss by the smaller production on the peasant farm and by the keeping of more work horses than the gain to the home farm (quoted from Kjærgaard, 1980, pp. 15–16).

In the account of Zealand Begtrup (Sjelland et al., vol. I, 1803, p. 138) where labor services still made up a substantial part of the rent we are told that tenants whose labor services were commuted to other types of rent seemed, at first, reluctant to buy their farm (an indication of the burden inflicted upon them by labor services).

This accords with more recent evidence. Stendal Pedersen (1987, pp. 50–51) in his examination of land sales finds that the new owner occupiers (in spite of their privileged position as buyers) nevertheless had paid a price substantially above the discounted value of estimated future rent which consisted mainly of commuted grain rent and commuted boon works. The likely explanation, as given by the author, is that commutation of boon works did not mirror the true costs of this type of rent to the tenant. Strong evidence on this point is found by Christensen (1889, p. 326) who recalculated information from 1801 originally collected by Begtrup concerning 60 estates on the island of Zealand. He estimated the value, i.e. the price to the tenant of full scale labor services due on a normal farm, at 76 Rix-dollars, but "by commutations the landowner barely fetched 30–40 Rix-dollars at that time." This is the heart of our argument in the explanation of the difference between points A and B in Fig. 1.

Another thing that has often been overlooked is that the detailed specifications of labor services – on what work could be carried out, and by what means – also served as a hindrance to landlords who would otherwise have preferred to employ a new cultivation system on the home farm (Bjørn, 1988, p. 23; Skrubbeltrang, 1978, p. 400), and Begtrup (Fyen, et al., vol II, p. 371). Eventually rising boon works, at a time when other agrarian reforms were launched, were met with increasing resistance from the peasantry in the form of strikes and protests (Bjørn, 1977).

A further reason for the landlord to attach a lower expected value to land in any region was his obligation to collect land taxes from the peasants. Despite its absolutist nature the State in eighteenth century Denmark was for a long time too weak to carry the load of local administration and had to resort to the traditional assistance of the landlords. This substantially added to the monitoring costs of land. When legislation in 1784 transferred the burden of tax collection to the Crown's prefects as far as the owner-occupiers were concerned it acted as an impetus to sell.

4. LAND SALES AND LAND PRICES – SOME QUANTITATIVE EVIDENCE

In the following sections extensive use will be made of one contemporary source of information. Agrarian economist *Begtrup* collected his regional account of

Danish agriculture during the period 1801–1810 from contemporary literature and information coming from his correspondence with prefects, land agents, ministers and others.[11]

Examples from *Begtrup* point in the expected direction. Interest paid by the freeholder on his debt to the former landlord were often double that of his previous land rent.

The tenants, contrary to expectations, were ready to buy their land. It may well be that real rents declined and that landlords, in their own interests, customarily had provided insurance in the form of seed grain, livestock, and horses to their tenants in emergencies. In most cases the peasants seemed to have been willing to forego these apparent benefits.

Table 3 indicates why this was so. Material gathered from all regions illustrates that within the same region, and within a short period of time, prices of land resold by the owner-occupier invariably doubled and sometimes trebled compared to the price originally obtained by the estate owner. All land sold to tenants at this stage was already enclosed. Consequently the possible benefits from enclosure do not influence prices.

This material is diversified, but it must be kept in mind that information on the two types of land sales flowed spontaneously to the author from different sources, thus underlining its relevant nature.

Price information in parts I and III (2) records differences when land was sold and resold within intervals of zero to six years, too brief a time for substantial improvements springing from ownership *per se* to surface. Farm number 3 in part I was sold again three years later, in 1805, at a slightly lower price than at its first sale, which indicates that its market price had been reached at the previous sale.

Price differences in parts II and III, (1) and (3), may or may not include the improvements to be expected, especially from the liberation from boon works. Another source of long run price rises could be subsequent land improvements carried out by the freeholder who would have held superior knowledge of the productive potential of the farm.

Begtrup and some of his contemporaries indiscriminatingly regarded the price differences as the ultimate proof of the superiority of owner-occupancy to tenancy. Tales of farms boosting their output in a matter of no time solely as a beneficial effect of ownership are, however, not credible. Rather, what we do see is the compound effect of other forces. To an increasing degree landlords wanted to sell their land to the tenants to rid themselves of an obsolete rental system. When selling they obtained a price above the discounted value of expected future income from the land. They did not, however, obtain the 'unconstrained' market price of land.

Table 3. Land Prices in Rix-Dollars.

	Average price when sold by landlord to tenant	Average price when sold by owner-occupier
I. Identical individual farms. Farmprice		
(1) Eastern Jutland	1700[a]	3225[b]
–	1500[c]	6364[b]
–	1200[d]	3921
(2) Zealand	1000[f]	1600[f]
–	1400[f]	2000[f]
II. More farms at the same year and same location. Price per Td. Hartkorn.		
(1) Ribe, Western Jutland	275[g]	550
(2) Falster	150[h]	350
(3) Funen	300[g]	775
(4) Zealand	200	500
III. More farms at the same estate at different years. Price per Td. Hartkorn.		
(1) Aarhus (Østergaard)	134[i]	631[h]
(2) Aarhus (Constantinsborg)	233[a]	727[h]
(3) Ringkøbing (Tolstrup)	325[b]	725[j]

(a) 1800, (b) 1804, (c) 1803, (d) 1799, (e) 1802, (f) 1798, (g) 1805, (h) 1806, (i) 1790, (j) 1810. Whenever resale takes place at a later year prices are deflated by rye prices. These prices rose more steeply than prices of the other main crop barley.

Source: Begtrup (1803–1812); Sjelland etc., vol. I, pp. 26–31; Nørrejylland vol. V, p. 73 and pp. 471–473, vol. VII, pp. 22–23; Fyen etc., vol. III, pp. 36–37, vol. IV, pp. 774–775.

5. MARKET CONSTRAINTS

As stated in the introduction, no landlord was ever forced by law to sell his land. A royal decree of 1769 apparently lent strong support to the principle of freehold in saying that,

> this must be to the common good of the country, since it cannot fail that the land will be better cultivated if the one who tills it knows, and is assured of, that the time, diligence and effort he employs on improving the farm and the land will benefit himself, his children and his heirs (quoted from Schou, 1795, p. 128).

A mild inducement to sell was offered: in the event that the sale of land to a tenant endangered the minimum size of the complete estate that would have ensured tax freedom on the home farm (200 *Td. Hartkorn*) tax freedom was, nevertheless, maintained. The decree, however promising, had little immediate impact. The state during the following five years, in particular, sold off crown land mainly as complete estates to landlords instead of selling it to its tenants. Freehold did not again become an issue until the late 1780s.[12]

The Danish land market of the late eighteenth-century was, nevertheless, discriminatory. Looking first at the landlords' sales to tenants, the latter enjoyed legal protection as the cultivators of taxable land.

Leasehold for life originated in the sixteenth-century and was confirmed by Christian V's 'Danish law' in 1683. No tenant should be expelled from his farm unless he neglected his land or forfeited his rent. This provision was further enjoined by a royal decree of May 19th 1790 following the attempts by some landlords to introduce short term leases or tenancy at will.

An important decree of 1784 released the landlord from the responsibility for his former tenants' land taxes on land he was about to sell. But this privilege, and the right already mentioned to remain tax free on manorial land, was only granted if he sold the farms to the *residing* tenants. As a consequence, the bargaining position of the tenant was strong from the outset. When a landlord wanted to sell, the tenant, at least in principle, could squeeze the price to the landlord's opportunity rent by refusing to buy at the price offered. He was the only buyer within a foreseeable number of years and he could not be evicted from his leasehold. Skrubbeltrang (1961) has estimated that only about 4–5% of the tenancies would normally fall vacant.

An example from the island of Funen shows that a farm that fetches between 200 and 350 rix-dollars per *Td. Hartkorn* when sold to the residing tenant sells at 500–600 rix-dollars at a vacancy. Holmgaard's (1990, p. 77) study of the speculative sale of a whole estate in Jutland found that individual farms were sold off at irregular intervals, not *en bloc* village by village, and not as it seems according to any particular plan. Besides, the prices obtained for the tenant farms sold last were lower than for the first, which was contrary to the general development in land prices. This, according to Holmgaard, suggests that tenants deliberately used their right to a lifelong lease when bargaining for a better deal.

Stendal Pedersen (1987, pp. 46–47) has examined an early land sale from an estate in 1761. Unlike Holmgaard he makes no reference to the bargaining position of the residing tenant. His results, nevertheless, point in the same direction: Out of 29 farms and cottages sold off in three villages 9 were sold to the tenants and of these 8 were sold at a land unit price below the average.

The above restrictions when the landlord sold to his tenants had *no* parallels when owner-occupiers wanted to sell parts of their newly acquired land to landless young people. During the land sales period considered here about 40,000 families settled on small plots of 4–5 acres. Part of this land was parceled out from the manorial farms, but the major part originated from the former tenant farms. The consequences are shown in Table 4. Fifty years after the great land sales period, owner occupied farms were substantially reduced in size compared to farms still under leasehold.

The small holdings were to supply the agricultural laborers needed for the more intensive cultivation methods that arose during these years – both on the manorial farms and on the owner-occupied farms. On the manorial farms they eventually replaced the tenants' servants doing boon work.

To sum up, there were definitely constraints on market forces when landlords sold to tenants, whereas the price at resale to cottagers, or to other farmers for that matter, probably came close to a free market price.

We now turn briefly to the capital market. In most of the country tenants did not encounter insurmountable difficulties in financing the purchase of their farm, according to Jensen (1957) – mainly for two reasons. First, there were well developed local loan markets. On wealthy Funen interest charged by fellow peasants was as low as 2.5–3%. Second, as we have seen, the new proprietor could reduce the amount of the loan quite substantially by parceling out land from the farm; lenders were well aware of this fact.

The policy of two public credit institutions *Den kongelige Kreditkasse* established 1786 to finance agriculture in general and *Den almindelige Enkekasse* a pension fund, shows the State's concern for owner-occupancy. Only a minor part of the necessary loans did, however, pass through these two institutions. The rest were granted from various private sources of which the single most important was the landlords themselves who furnished about 20% (Christensen, 1950–1952).

Table 4. Percent of Farms by Size (*Hartkorn*) and Tenancy on Funen 1850.

	1–2	2–4	4–8	8–12	Total
Leasehold	9	13	71	7	100
Freehold	26	29	36	8	100

Source: E. Porsmose, *De fynske landsbyers historie*. Odense, 1987, p. 261. *Hartkorn* is a measure of the taxation value of land, cf. Note 3.

6. OPPORTUNISTIC BEHAVIOR BY TENANTS

As we have seen in Section 3, landlords attached a lower expected value to leased land than did the leaseholders. In addition to this, tenancy arrangements prior to the land sales gave rise to a violation of the asymmetric information condition. As for the tenants' motive to disguise the true value that can be extracted from the land *Begtrup* is illustrative; "The tenant farmer considers all efforts to improve the farm buildings or the land as an enrichment of the landowner thus enabling the latter to charge a higher entry fee and a higher rent at the change of tenant. Consequently it will burden the tenant's own son, were he to succeed his father." (Sjelland et al., vol 3, 1803, p. 177) And when comparing owner occupied with tenant farms on the island of Funen he observes that the latter "always try to conceal their wealth so that the rent shall not rise too high after their death" (Fyn et al., vol. 5. 1806, p. 78).

7. THE LANDLORDS' OPPORTUNITY INCOME

To further strengthen the case for the landlord's wish to sell his tenanted land it is useful to take a look at his alternative. How could he more profitably invest his sale proceeds? Holmgaard (1990, pp. 302–303) unambiguously states that the return on these sums exceeded former rents paid by the tenants.

In the Danish case there is no doubt that the answer lies in a much needed intensification of cultivation on the manorial home farm. Christensen (1998, p. 14) sums it up most accurately,

> . . . the landlord needed liquid assets so that he could buy modern implements, raise his own, bigger horses [compared to peasants' horses], build stud farms, bigger stables and storing places for more manure and be able to pay cottagers and day-labourers. That is mainly investments in a more rational cultivation of the home farm land.

What then remains to be accounted for are the cases, mainly found on the island of Zealand, see Table 1, in which landowners made their tenants copyholders of inheritance. As already said, this amounted to propriety ownership from the point of view of the tenants, but from the point of view of landlords it certainly differed from land sales in its effects.

To answer this one must look at the landowners in point. They fall roughly in three categories. The first, and perhaps less interesting, consisted of wealthy landowners with vast amounts of land. Some were part of or connected to the influential circle of land reformers while others were royal persons.[13]

The second category consisted of land belonging to institutions like the University of Copenhagen, the county of Copenhagen, and the Sorø institute

of higher learning. Rents from this type of land were traditionally below that of privately owned estates as far as this can be calculated. Institutions during the second half of the eighteenth-century often chose to make their tenants copyholders of inheritance against what was considered a fairly modest annual income. There is an obvious parallel to this operation, that of similar English institutions during the nineteenth-century where ancient tenures survived amidst the dominant system of rack rent. Turner and Beckett, in their analysis of English college land, states that so called beneficial leases were favored by institutions because they received an income from the land but with minimum expenditure and supervision (Turner & Beckett, 1998, p. 106).

Thirdly, the holders of estates under so-called strict settlement were effectively prevented from selling to tenants since they had no disposal of the sale proceeds. They seem to have found the transfer of their peasant land to copyhold of inheritance a second best solution.

8. CONCLUSION

Landlords' sales of peasant land to tenants represented a gain to both buyers and sellers. A major reason for this was the existence of the differential value of labor services, so-called boon works, as an important element of land rent. No doubt there were monitoring advantages of farm servants on peasant farms compared to the situation where the same servants performed boon works on the manorial home farm. According to a contemporary estimate the landlords' benefit from this labor was one half and even sometimes one third of the tenant's opportunity costs. Hence, boon works was a major cause for the differential efficiency between peasant production under leasehold compared to freehold.

Furthermore, State protection of tenants in the form of leasehold for life put them in a strong bargaining position *vis-à-vis* the landlord. The evidence presented here suggests that this enabled the tenants to capture the lion's share of the efficiency gain from the exchange of peasant land.

Legal protection of tenants as the cultivators of taxable land is known from other parts of Continental Europe. What effectively enabled the Danish tenant to buy the land he farmed was a well functioning informal loan system combined with a high land/labor ratio at a time when the terms of trade favored land. Danish population density prior to the land sales is estimated at one half to one third of that of Britain, France, and Germany (Jensen, 1987, p. 104). During 1750–1800 Danish population increased by 20%. Consequently, the new freeholders were able to finance their purchase by parceling out plots of land for young, landless people. Contemporary evidence tells us that this opportunity was seized eagerly.

In the analysis, price information concerning land sales from landlords to tenants was compared to prices at resale by freeholders. This comparison emphasized the differences in efficiency between the two types of tenure. At the same time the figures are a strong indication of the imperfections in the land market that favored the residing tenant.

Finally, it is suggested that tenants added to their gain by exploiting asymmetries of information when concealing their current income. The landlord, having had better information, might otherwise have exercised his right to increase rents at the change of tenant and that, in many cases, would have damaged the tenant's own son.

As land sales were beginning to ebb around 1807, the government probably reinforced trend by removing the tax benefits for landlords who sold to tenants. Some sales still took place during the years of war inflation (1807–1818) whereas the European agrarian crisis (1818–1840) brought them to a complete halt. The sales to freehold tenure were revived in the 1850's and in 1885 only 9% of the land was leased to tenants.

NOTES

1. In the following it is assumed that the term 'real rent' is identical to 'economic rent' or Ricardian rent since the land owners probably regarded the increase in population as a justification for a larger share in factor income going to land.

2. Christensen (1950–1952) suggests that 'the [*de facto*] prohibition against raising rents had created a discrepancy between the capitalization value of rent and the market value of land such as it appeared by the sales to ownership'.

3. Land here and in the following is measured in so-called *Hartkorn* according to the valuation of the 1688 Land Register. The valuation was made for taxational purposes and consequently the acreage of a *Td. Hartkorn* varies with land quality – typically between five and fifteen acres.

4. Copyhold was all but ownership in the Danish context since it entailed the right of the owner to transfer, sell or mortgage his farm and even to divide it into more parts. This form of tenure was often employed on Crown lands and on estates under strict settlement, see Section 6.

5. T. C. Smout, in an article from 1987, puts it down to 'a unique combination of circumstances' namely legal protection of the peasants, the commutation of flexible rents in kind to fixed money rents and inflation.

Danish historian F. Skrubbeltrang regards the process towards freehold in the late eighteenth century as a gradual one, during which the longest step to complete propriety ownership was taken in the regions of Denmark, mainly Jutland, that already had a tenancy arrangement closely resemblant to copyhold. Son succeeded father on more than 60% of the leaseholds. During that same period progress in the old areas of villeinage, Zealand and the islands south of Zealand, was much slower.

6. In his investigation on land sales Sigurd Jensen (1950) gives little attention to the question of motive. Possibly some landlords, according to him, opted out as a protest

against reform legislation. He also refers to various cases of 'speculative' sales although he readily admits that landlords must have been faced with a dilemma not knowing when prices had peaked.

7. In the following the two terms 'boon works' and labour services are used interchangeably.

8. Under the realistic assumption that the gain from the rise in grain prises are not shared equally between land and labour. That probably holds true even if land supply in the Danish case was not yet totally fixed due to remaining uncultivated land.

9. A lower estimate of the difference can be gained from Falbe Hansen (1888, p. 112), who reports the size of home farms on mortgaged estates as 34 *Td. Hartkorn* in Jutland and 60 on Zealand. This is an underestimation of size difference since it generally took more acres to make up a *Td. Hartkorn* in Jutland and also because there were more estates under strict settlement in Zealand. These estates that could not be mortgaged were larger than the average estate.

10. More on the author in Section 4 below.

11. Begtrup from 1801 until his death in 1841 taught agrarian science at the University of Copenhagen (to future ministers of the Danish church). Prior to that he had travelled extensively in Europe and spent the best part of a year in England, in 1797, consulting Arthur Young and John Sinclair among other. Young's report on agriculture in the British counties was clearly a model to Begtrup. His own account of Danish agriculture obtained royal sponsorship and that leads us to believe that his personal comments to the information presented does not differ radically from the official opinion of his time.

12. It turned out that a number of tenants who had bought crown land in the 1760s were bad debtors unable to pay interest and repayment on the mortgage the state had in their farm. The state under the circumstances put the fiscal motive before the principles of 'property and liberty'.

13. A modern historian has dubbed this transfer of some of the land as a 'showcase' that was to advertise the effects of land reform in general and maybe to elevate the owners in public opinion (Kjærgaard, 1980, pp. 215–216).

ACKNOWLEDGMENTS

This article has benefited from comments by Karl Gunnar Persson and S.P.Jensen, Copenhagen and from the discussions at the Conference titled Land, Labor, and Tenure (a pre-conference for the IEHA meetings in Madrid) at the University of Leicester, 21–24 August, 1996. Responsibility for all remaining errors rests with the author.

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APPENDIX

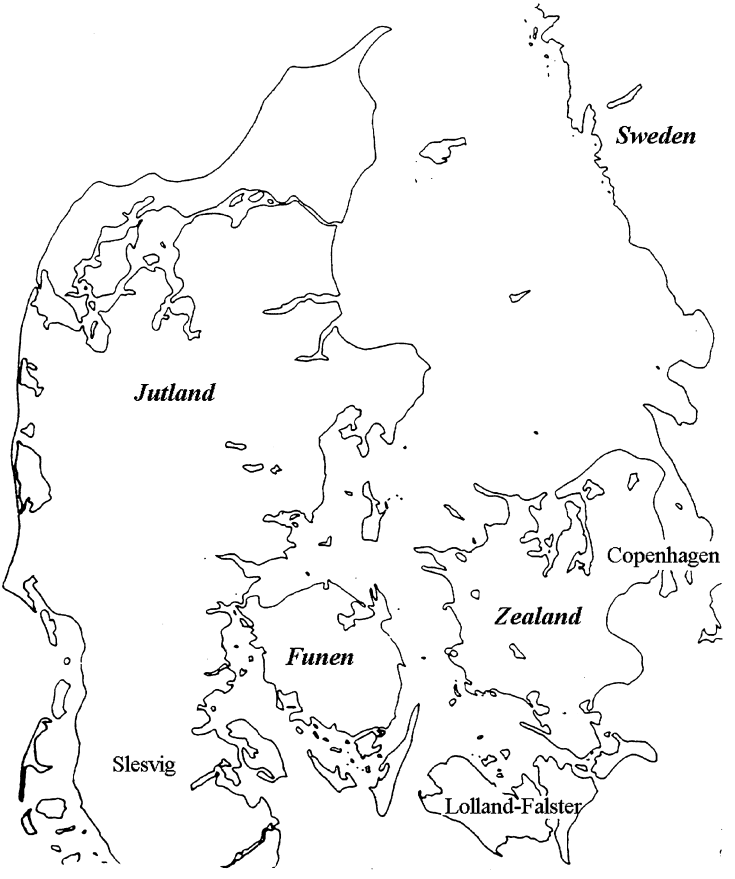

Fig. 2.

THE COMPLEXION GAP: THE ECONOMIC CONSEQUENCES OF COLOR AMONG FREE AFRICAN AMERICANS IN THE RURAL ANTEBELLUM SOUTH

Howard Bodenhorn

> Whether by design or happenstance, it was costly to be black even in the black community. (Johnson, 1996, p. 78).

INTRODUCTION

Historians of nineteenth-century race relations emphasize the primacy of complexion not only in interactions between whites and African Americans but between African Americans of different colors as well. Acting on sentiments formed and reinforced by the white majority, Americans of both races demonstrated clear preferences for light skins, and African American leaders were disproportionately drawn from the light-skinned segment of the population. This phenomenon is well documented for antebellum U.S. cities, Britain's Caribbean colonies, and large parts of Central and South America. Charleston's mulatto elite, for example, aligned themselves politically and socially with the city's white leaders, and the organization that best symbolized Charleston's mixed-race elite, the appropriately named Brown Fellowship Society, admitted

Advances in Agricultural Economic History, Volume 2, pages 41–73.

ISBN: 0-7623-1001-4

only fair-skinned mulattoes. A regular event on New Orleans' social calendar was the so-called quadroon ball where wealthy white men courted eligible, light-skinned African American women and paid for the privilege of taking a mulatto mistress (Williamson, 1984, p. 23).

Subtle complexion distinctions did not fall strictly within the purview of New Orleans and Charleston sophisticates. Bogger (1997, p. 104) found that Norfolk, Virginia's African Americans were deeply color conscious, especially when choosing a marriage partner. Horton (1993) documented mulatto advantages in Cincinnati, Buffalo, and Boston. Hershberg and Williams (1981) uncovered a similar effect in nineteenth-century Philadelphia. Litwack (1961, p. 182) concluded that light skin might not guarantee African American success, but it opened some doors normally closed to blacks. Johnson (1996, pp. 16–17) found that in Savannah "color was a greater obstacle to social interaction among people of African origin than either culture or legal status."

Even though they argue that the early-nineteenth-century urban African American community operated within the context of an intricate socioeconomic hierarchy based on subtle gradations in skin complexion, historians argue the same sorts of complexion-based differences failed to appear in the rural Upper South (e.g. Maryland, Virginia, and North Carolina) during the antebellum era. Mencke (1979, pp. 18–19) wrote that whites in the Upper South were not inclined to distinguish mulattoes from blacks. The entire class of free African Americans was "viewed as a social sore, a dark, threatening force potentially fomenting rebellion among the slave population." Davis (1991, pp. 26, 31, 33–34), too, argued that Upper South whites drew no effective color distinctions, certainly none significant enough to provide light-skinned mulattoes with any sort of social or economic advantage. Horowitz (1973, p. 515) drew the traditional interpretation in starkest relief. He argued that in Britain's Caribbean colonies, the mulatto group grew ever more esteemed, elevated to a distinct intermediate class, even while Upper South mulattoes were being pushed down into a mass of "blackness" – a downward push that began in the colonial period and continued throughout the subsequent two centuries.

Utilizing information collected from the 1860 manuscript census records of twenty-six rural southern counties, this article builds on other recent studies which show that the traditional interpretation is debatable.[1] Evidence from the population and agricultural censuses show that mixed-race men moved from farm laborers to tenancy earlier and in greater proportions than black men. Similarly, a greater proportion of mulatto men ultimately owned their own farm than did black men. It is not surprising then that mulatto heads of households accumulated significantly more personal property than black-headed households. Using quantile regression methods, this article reports a marked complexion

gap in the upper half of the African American wealth distribution of the antebellum Upper South. Thus, color was as important a determinant of race relations in the rural Upper South as it was in the urban Lower South. Historians failed to recognize this complexion gap because an outspoken, socially visible, and politically active mulatto elite never emerged in rural areas, but the emergence of a visible mulatto elite and the primacy of color were not synonymous in southern society.

MISCEGENATION AND MULATTOES IN THE UPPER SOUTH, 1620–1860

Africans first arrived in the Virginia colony in 1619 or 1620 and almost immediately began forming intimate relationships with whites. Guild (1969, p. 21) found that the first reference to an African American in Virginia's legislative record appeared in 1630 and represented the opening salvo in a long battle against miscegenation. The colonial council ordered Hugh Davis to be soundly whipped for lying with a black woman, an act he was forced to publicly acknowledge on the Sabbath. A decade later, Robert Sweet was forced to do penance in church for getting a black woman with child. The woman was whipped.

Concerns with miscegenation ultimately provoked a significant colonial departure from English legal tradition. Tradition held that a child's status followed the father's. In miscegenation cases identification of the father was often problematic, thus it was simpler to inhere the mother's status to the child. In 1662 Virginia law made the mulatto child of a slave woman a slave (Guild, 1969, pp. 23–24). Until 1691 the mulatto child of a white woman was free, but an assembly act of that year imposed a penalty of five years' forced servitude on the white mother and thirty years of servitude on the mulatto child (Guild, 1969, pp. 24–25; Davis, 1991, p. 33).

Although they labeled it servitude, most colonials treated it as de facto slavery. Many masters kept their mulatto servants in lifetime bondage, others released them only when forced by the courts to do so. Ann Redman's case is instructive. Ann, a mulatto woman and daughter of an English woman, was ordered "freed from *slavery* and discharged from the service of Thomas Lloyd" of Richmond County, Virginia who had previously refused to release her (Johnston, 1970, p. 178, emphasis added).[2] Courts were forced to intercede in many instances because masters sometimes sold these servants to others, representing them as bona fide slaves. The practice became serious enough that in 1765 the legislature levied punishments for failing to release mulatto children on their thirty-first birthday or selling them to others without notifying the buyer

of their true status (Guild, 1969, p. 58). While it has been true in all epochs, the dictum that children should choose their parents carefully applied with particular force in colonial Virginia.

Interracial affairs, once discovered, carried a stigma in the U.S. not seen in other slave societies. In the British West Indies and Portuguese South America, gender imbalances among whites led to widespread miscegenation. It was likely that European planters in the West Indies and elsewhere were initially as squeamish about racial mixing as their North American counterparts, but demographic forces quickly overcame reservations. Horowitz (1973) and Degler (1971) argue that by the mid-eighteenth-century, miscegenation between white planters and black slaves was widespread, mulatto progeny commonplace, and manumission the rule.

The same was not true in North America. Despite more balanced gender ratios, whites and blacks carried on illicit affairs that resulted in mulatto children. To many contemporary southerners, miscegenation was reprehensible, but manumitting the progeny was a singularly dangerous, antisocial act. Degler (1971, pp. 194–195) argues that most whites believed it better that half-white offspring live a lifetime in bondage than have free society populated with mixed-race African Americans. Virginia law discouraged manumission, first by requiring planters to post bonds guaranteeing that the manumitted slave would not become a charge on the county's poor relief rolls, then in 1806, by requiring manumitted slaves to emigrate within twelve months of manumission or face sale back into slavery (Guild, 1969, p. 72). Few masters would free a slave only to see her sold into the service of another, perhaps someone less kind.

Not unexpectedly, legislative attempts to thwart miscegenation failed. According to the 1860 census, the Upper South was home to more than 61,000 free mulattoes (36% of the free African-American population) and 102,000 mulatto slaves (11% of slaves). But it seems likely that the 1860 census under-reported mulattoes relative to blacks. Registers of free African Americans taken from sixteen Maryland counties imply that more than 44% were free mulattoes (Komlos, 1992, p. 303). Similarly, Bodenhorn (1999a) reports that registers from twenty-three Virginia counties described about 63% of free-born African Americans as mulatto. Census enumerators were asked to distinguish between mulattoes and blacks and they apparently tended to identify only the fairest complected African Americans as mulatto.[3]

A thorny political and moral issue revolved around how to define this mixed-race population. Some historians argue that the so-called "one drop rule" (a single drop of black blood made one black) that became the standard under Jim Crow had antebellum, perhaps even colonial, roots (Davis, 1991, pp. 31–34; Degler, 1971, pp. 241–243; Mencke, 1979, pp. ix–x). Davis

(1991, pp. 33–34) argued that the one drop rule became the accepted social standard by the early-eighteenth-century, but he recognized that the mulattoes' legal status remained in flux throughout most of the eighteenth-century. Degler (1971, pp. 241–243) cites southern case law from the eighteenth- and nineteenth-centuries to support his contention that blacks and mulattoes were, as far as southern law and southern society was concerned, one and the same.

Degler's seems an extreme interpretation given that in 1785 Virginia legally defined a person as black if he or she had one black grandparent (Guild, 1969, p. 29). For many southerners, this dividing line between white and black was still too generous. Williamson (1984, p. 13) contends that a one-quarter delineation created a distinct class of people "who were significantly black, visibly black, and known to be black, but by the law of the land and the rulings of the court had the privileges of whites." Most whites preferred sharper distinctions. Historians insist that Upper South whites may have been forced to recognize the distinction de jure, but refused to do so de facto. Instead, Upper South race relations aimed to make all African Americans black even while Lower South whites elevated mulattoes to a distinct intermediate class (Horowitz, 1973, p. 515).

Horowitz (1973) and Mencke (1979) argue that differences in the attitudes toward mulattoes of Upper and Lower South whites arose out of regional differences in mulatto ancestry. As previously noted, West Indian and Lower South mulattoes tended to be the offspring of wealthy white men and black women, either slave or free. Thus, mulattoes were the progeny of the elite, were recognized as such and provided with many of the advantages that followed from having a wealthy parent. Nearly all were manumitted, most were educated, many even inherited from their father's estates. Upper South mulattoes, on the other hand, were more likely to be the offspring of poor whites and even poorer slaves. Mixed-race people of the Upper South, then, were overwhelmingly poor and carried a mark of poverty throughout their lives.

For many historians, portraying Upper South white society as decidedly monochromatic follows from the incongruence of mulattoes and slavery that made many Upper South whites uncomfortable. Nevertheless, some slaves were at least partially white. Although the censuses are imperfect sources, the 1850 census identified about 10% of Virginia's slave population as mulatto. By 1860 about 15% were so identified. In other Upper South and border states, the proportions were higher yet; close to 20% in Kentucky and Missouri (Mencke, 1979, p. 21). No amount of moral maneuvering and no legalism could hide the fact that some slaves were part white, but if law or society recognized these people as white (of any degree), the premise that only blacks were slaves would have been violated. To ease their consciences, it was imperative to view those

with even the smallest trace of black heritage as black. To do otherwise would have been to enslave whites as well as blacks. Defining all African Americans as black maintained the fiction that blacks were slaves and slaves were black.

Upper South whites, then, are portrayed as unremitting in their efforts to disavow the mulattoes' white heritage and historians are nearly as unremitting in their efforts to portray Upper South whites in this way. In summarizing his thesis, Degler (1971, p. 102) states that there "are two qualities in the United States racial pattern: white and black. A person is one or the other; there is no intermediate position." The evidence presented below belies this interpretation. Both the African American and white communities drew more sophisticated color distinctions. Both groups recognized subtle gradations rather than sharp lines. Contemporary whites, in fact, commonly described African Americans as black, brown, copper, olive, nutmeg, ginger, chestnut, and yellow, among others. Of course, observing differences and acting on them were different things, but the evidence suggests that the white and the African American communities both saw and acted on complexion differences. Finding that both communities recognized gradations should not come as a surprise. Few things are either black or white most demonstrate subtle gradations. Upper South society's response to mulattoes (the personification of color gradation) was more complex than previously believed.

ASSESSING THE 1860 CENSUS AS A DATA SOURCE

Data on the occupations and personal wealth of free blacks and mulattoes living in the antebellum South were taken from a sample of twenty-six rural southern counties included in the 1860 manuscript census.[4] Because most free African Americans lived in the Upper South, the sample is heavily weighted with counties from that region, including eight from Maryland, nine from Virginia, five from North Carolina, two from Kentucky, and one each from Tennessee and Louisiana. Summary statistics reported in Table 1 outline the information collected on about 7,000 African American households, divided into four groups: households headed by mulatto men; households headed by mulatto women; households headed by black men; and households headed by black women. It is a large cross-section of free African American households and should therefore be representative of their experience in the antebellum Upper South.

Recent research, however, has questioned just how representative samples drawn from the census manuscripts may be. Three types of shortcomings are fairly well documented for the manuscript censuses – underenumeration, misreporting, and missing data – and each has distinct implications for sample

Table 1. Characteristics of Free African American Sample Means (Standard Deviations).

	Black Men	Black Women	Mulatto Men	Mulatto Women
Age	43.03	43.31	40.52	41.34
(yrs)	(12.99)	(13.14)	(13.11)	(13.05)
Property	93.55	36.02	142.34	92.65
($)	(299.69)	(188.24)	(521.75)	(409.77)
Household	5.02	4.20	5.25	4.20
	(2.59)	(2.32)	(2.78)	(2.39)
Laborer	0.66	0.37	0.48	0.22
%	(0.47)	(0.48)	(0.50)	(0.41)
Farmer	0.16	0.02	0.24	0.09
	(0.37)	(0.14)	(0.43)	(0.28)
Watermen	0.02	–	0.02	–
	(0.16)		(0.14)	
Skilled	0.05	–	0.14	–
	(0.22)		(0.35)	
Merchant	0.00	–	0.01	–
	(0.06)		(0.10)	
Domestic	–	0.06	–	0.06
		(0.23)		(0.23)
Seamstress	–	0.01	–	0 05
		(0.11)		(0.23)
Washer	–	0.15	–	0.15
		(0.36)		(0.36)
Service	–	0.02	–	0 03
		(0.14)		(0.18)
Spinster	–	0.00	–	0 05
		(0.07)		(0.21)
Maryland	0.74	0.56	0.29	0.17
	(0.44)	(0.50)	(0.46)	(0.37)
Virginia	0.18	0.33	0.16	0.29
	(0.39)	(0.47)	(0.36)	(0.45)
N.C.	0.06	0.08	0.49	0.46
	(0.24)	(0.28)	(0.50)	(0.50)
Tennessee	0.00	0.00	0.01	0.02
	(0.00)	(0.04)	(0.12)	(0.12)
Kentucky	0.01	0.02	0.02	0.03
	(0.11)	(0.13)	(0.13)	(0.17)
Louisiana	0.00	0.00	0.03	0.05
	(0.04)	(0.06)	(0.16)	(0.21)
N	3,859	1,493	1,259	529

Note: Laborers include day labor, ditchers, fencers, railroad hands, waiters, and miners. Farmers include farmers, planters, plantresses, and tenants. Waterman include sailors, seamen, oystermen, mariners, boatmen, and fishermen, Skilled includes carpenters, blacksmiths, sawyers, butchers, brickmasons, stonemasons, coopers, barbers, wagoners, shoemakers, ropemakers, painters, turners, wheelwrights, ciger makers, millers, turpentine distillers, engineers, and a fiddler. Merchants include merchants, traders, drummers, resaurant owners, marketmen and preachers. Domestics include domestics, housekeepers, servants, and cooks. Seamstresses include seamstresses, dress makers, and weavers. Washers include washerwomen and laundresses. Services include cakesellers, nurses, midwives, fortune tellers, boarding house operators, and prostitutes.

Source: 26 county rural southern census sample. See Bodenhorn (1996b) for a description of a sample and sampling method.

reliability. If enumeration errors were random, statistical inferences would be relatively unaffected. The extant research, however, suggests that enumeration problems were sometimes extensive and generally nonrandom. Estimates of underenumeration range from about 9% to 23%, depending on geographic region and the group under consideration (Adams & Kasakoff, 1991; Steckel, 1991, p. 588). The poor, the unskilled, the young, the mobile, residents of large cities and the frontier, and minorities were all more likely to be overlooked by census enumerators than middling class, educated, skilled workers who had resided in the same small community for several years.

Knowing that poor, unskilled, minorities were more likely to be underenumerated than others raises several potential red flags for a sample of free African Americans drawn from the 1860 manuscript census because all fell into at least one category. Free African Americans were less skilled, on average, than whites; they are believed to have been less wealthy; and they were unquestionably in the minority. At the same time, free African Americans tended to belong to more accurately enumerated groups; state- and county-level legislation rendered them relatively immobile, and they tended to reside in long-established, stable, small rural communities. Thus, determining the extent to which southern free African Americans were underenumerated requires comparisons to alternative sources of information.

Fortunately for the historian, white concerns with the activities and movements of free blacks meant that a great deal of information was gathered about them. In addition to the registration requirement (Maryland, Virginia, and some North Carolina communities required this), Virginia required court clerks to compile an annual census of free African Americans residing within their jurisdiction, identifying each individual by name, age, and occupation. Most of these lists are lost, but the 1860 list for Fauquier County, Virginia is extant, rendering comparison to the census easy.

The 1860 census manuscript for Fauquier County enumerated 121 African American household heads. Only 49 of those householders were identified in the clerk's list. The clerk's list did not separately identify household heads so it does not allow us to determine the extent to which the census underenumerated heads of households, but this (small) piece of evidence induces some confidence in the census's coverage.

A second independent source of information on free African Americans is the state tax lists. Virginia imposed special head taxes on free African American men. In addition to property taxes, a legislative act of 1852 imposed a $1.00 head tax on every black man between 21 and 55 years (Virginia, 1852, pp. 4–5). In 1859 an additional $0.80 head tax was imposed on the same group (Virginia, 1859/1860, p. 59).[5] Given the discriminatory taxes payable by free

African Americans, it would be reasonable to assume, as Blocker (1996, p. 25) has, that county tax collectors, being entrusted with a fiduciary responsibility, "had a stronger interest than census enumerators in identifying all property holdings," making the tax lists more complete and accurate than the census enumerations.

The results of matching the 1860 Virginia personal property tax lists (in which the head taxes were also recorded) with the 1860 census population manuscripts for five Virginia counties belie Blocker's expectation. Census marshals enumerated 576 households headed by male African Americans, 481 of which reported personal property holdings.[6] The five county tax assessors recorded only 317 (55%) of households enumerated in the census. Moreover, Fig. 1 suggests that neither source provides biased coverage of African American households. The figure compares the wealth-based frequency distribution of those reporting personal wealth in the federal census with those appearing in both the federal census and the state personal property tax lists. At every wealth interval the state tax assessor missed about one-half of African American households enumerated in the census. Because the frequency distributions are similar, it suggests that any census under-enumeration was random so that statistics derived from the census should be unbiased to the extent that the reported information is indeed accurate.

But another oft-noted problem with manuscript censuses is the extent to which and the direction in which they misreported socioeconomic variables, such as age, wealth, and occupation. Steckel (1991) found evidence (direct and indirect) of age-heaping, especially at ages ending in 0, 2, and 5. There are few alternatives sources to which to compare ages, but the Fauquier County clerk reported ages in his annual enumeration of 1860. The census marshal's and the county clerk's reported ages are in general agreement, although the census did report a greater proportion of ages ending in 5, which should not bias age-dependent calculations, but simply reduce their precision so long as approximately equal proportions of ages were rounded up as rounded down.

Although the 1860 federal manuscript census has come under attack as a reliable statistical source, it emerges here as in Blocker (1996, pp. 33–34), despite known and unknown enumeration problems, as a "more complete and accurate tabulation" than most alternatives, such as property tax lists. The comparison sources in this instance (Virginia state tax lists and county clerk's enumerations) have their own shortcomings, and the census stands out as a superior source. It is as Donald Parkerson (1991, pp. 514–515) noted, a matter of perspective. Is the census glass partly empty, or is it nearly full? He concluded that it is remarkable just how full the census glass actually is.

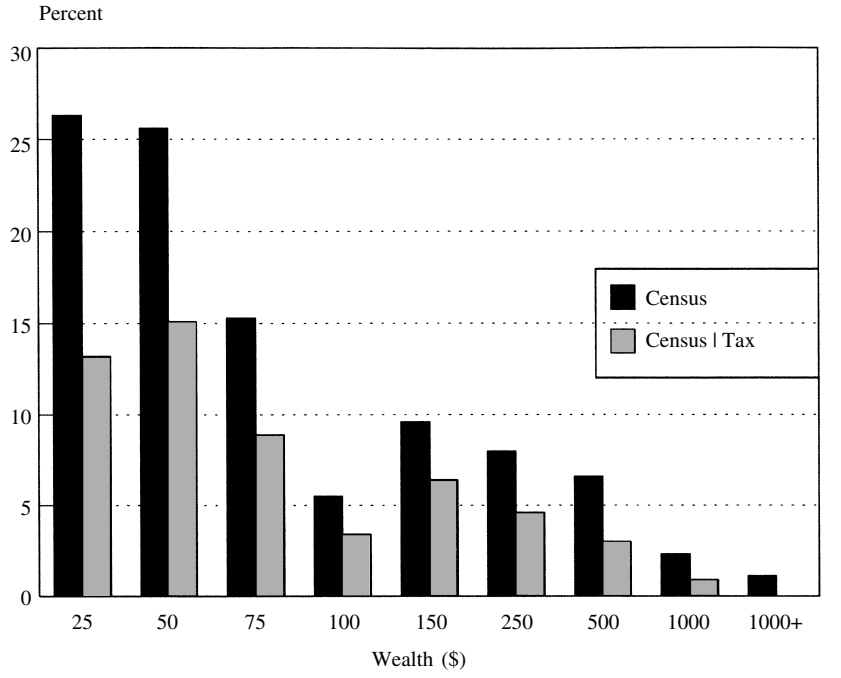

Fig. 1. Frequency of Census Wealth Holders and Census Wealth Holders Who Also Appear in the Virginia State Tax Lists.

Source: 1860 manuscript census, see Bodenhorn (1999b); Virginia (1860).

THE COMPLEXION GAP AND THE AGRICULTURAL LADDER

Agricultural historians have long relied on the metaphor of the agricultural ladder, likening socioeconomic advance in an agricultural community to movement to ever higher rungs on a ladder (Bogue, 1963; Winters, 1978, 1987). The simplest version of the ladder thesis, like that presented in Atack (1989) posits three steps: agricultural laborers occupy the lowest rung of the ladder, tenants occupy the intermediate rung, and owner-operators occupy the highest rung. Other versions posit longer ladders with more rungs. Laborers may be hired by the day, the season, or the year. Similarly, tenants may be sharecroppers, share tenants, or cash renters; part-owners might own only a fraction of the land they farm and rent the remainder; and owners can be mortgaged or hold their real

property in fee simple. Regardless of the number of rungs, or the distance between them, the essential thesis is that socioeconomic advance occurs through successive upward movement from landless laborer to outright owner.

Outright ownership was clearly the preferred state of affairs for most rural folk, but many worked as farm laborers, and farm tenancy occurred throughout the antebellum South (Reid, 1976). Tenancy provided access to farm land for those unable to purchase their own (Winters, 1987, p. 37). Simultaneously, it produced income for owners unwilling or unable to farm their own land, and this may have opened the niche exploited by Upper South African Americans. Contemporary reports in such disparate outlets as the *Baltimore American* (9 June 1859) and the Virginia House (*Journal*, 1847/1848, p. 20) remarked that, in the absence the region's free African Americans, large tracts of the region's arable land would have gone untilled. Moreover, migrants might rent for a year or two to determine if the land and the neighborhood suited their needs. Tenancy, too, may have served an educational or apprenticeship-type function even while young men acquired the wherewithal to buy their own farms.

Because antebellum censuses did not explicitly report on land tenure, inferences about it are based on subjective interpretations of imperfect and inexplicit data.[7] The long-held view is that tenancy was rare in the antebellum South, but Winters (1987) argues that tenancy was common.[8] Based on a study of eight counties in Tennessee, which Winters claims should provide a representative cross-section of the noncotton South, he finds that tenancy rates in 1850 and 1860 ranged from a low of 3.9% to a high of 29.2%. In a similar study of sixteen Georgia counties in 1860, Bode and Ginter (1986, pp. 180–181) found tenancy rates ranging between 3.4 and 42.6%. Although tenancy rates varied dramatically, Winters (1987, p. 40) as well as Bode and Ginter concluded that farm renting and tenancy were an "integral part of the agricultural structure" of the antebellum South. Whites were moving up the agricultural ladder. The question is: Were African Americans able to do so as well?

Before that question can be answered satisfactorily, several issues of interpretation need to be resolved. The fundamental problem facing researchers using antebellum censuses is how to treat people identified as farmers in the population manuscripts and not enumerated in the agricultural censuses. (The opposite case of appearing in the agricultural census and not in the population census occurs very infrequently.) Nearly as many methods have been devised for dealing with these so-called "farmers without farms" as there have been researchers using the censuses. Allan Bogue (1963), for instance, labeled individuals described as farmers in the population census without a corresponding entry in the agricultural census as hopeful farm laborers. Bode and Ginter (1986) argue that some of these men were surely tenants. Atack (1989, p. 9) is uncomfortable

with Bogue's treatment of landless farmers as laborers, but remains reluctant to classify them as tenants. He therefore excludes them from his analysis. Bogue's method produces a lower bound estimate of tenancy and an upper bound estimate of farm laborers. Atack's estimates produce lower bounds for both tenancy and laboring. Bode and Ginter's methods produce intermediate estimates.

Instead of adopting a previously used classification scheme a priori, it seemed more reasonable to let the data provide some insight on how best to treat variously identified individuals, particularly since any classification will be used to describe a previously ignored population of free African Americans. Table 2 provides sample averages for different groups arrayed according to occupational descriptions given in both the population and agricultural censuses of 1860. In nearly every county, enumerators separately identified "laborers" and "farm laborers." Given that the sample is drawn from predominantly rural, agricultural counties, it seems likely that most laborers (row 1a) were farm laborers (1b), but the fact that the same enumerators labeled them differently seems curious. Nevertheless, the group of laborers and the group of farm laborers appear to be very similar. Although laborers were about two years older and had acquired about $20 more real property, the percentage of blacks exceeds 80% in both groups, both had 4.8 household members, and both had acquired about $67 in personal property. Because of their similarities, the two groups are combined in row 1. Doing so creates an upper bound estimate of farm laborers, which also results in lower bound proportional estimates of tenants and farmers.

Row 2 in Table 2 reports information on tenants, which are defined as individuals identified as farmers in the population census and who appeared in the agricultural census without real property in the population or agricultural censuses. This is similar to Bogue's definition. Similarly, farmers (row 4) are those identified as farmers in the population census and who appeared with real property values in both the population and agricultural censuses. It is the individuals reported in row 3, or "farmers without farms," that are vexing. These men were identified as farmers and reported positive real estate holdings in the population census, but could not be matched to the agricultural census. Comparing their characteristics with those of tenants and farmers suggest that farmers without farms formed an intermediate class, most likely engaged in agriculture under some form of tenancy. They tended to be lighter complected than laborers and farmers, but darker than tenants. They were about four years younger than farmers and about 1.5 years older than tenants. They lived in smaller households than either tenants or farmers, but larger households than laborers. They held about the same dollar value of personal property as tenants,

Table 2. Characteristics of Free African Americans by Occupation.

	Percent Black (%)	Age (yrs)	No.in House (#)	Real Estate ($)	Personal Estate ($)	Average Farrn Value
1a. Labor	0.85	42.9	4.8	207.63	67.64	–
1b. FarmLabor	0.81	40.8	4.8	185.03	66.35	–
1. All Labor	0.84	42.2	4.8	205.48	67.35	–
2. Tenants	0.52	43.1	6.6	550.67	216.89	1,707.57
3. Farmers without Farms	0.67	44.6	5.7	756.21	238.13	–
4. Farmers	0.71	48.5	6.6	1,089.11	575.15	1,216.79

Notes: Row 1 averages are averages of Rows la and lb combined. Farmers without farms are those farmers listed in the population manuscripts as a farmer with reported real estate values, but not appearing in the agricultural census manuscripts. Average farm value column is value of farrn recorded in agrciultural census. Averages for real and personal property are averages only for those reporting a value. The statistical issues surrounding missing or censored data are discussed below. *Sources*: 1860 federal census population and agriculture manuscripts. For sampling method see Bodenhorn (1999b).

but much less than farmers. Finally, those reporting real estate holdings reported about $200 more than tenants, but about $300 less than farmers. Thus, these farmers without farms held substantial wealth, both real and personal, so excluding them from the analysis seems likely to misrepresent farm tenure in the antebellum South, so they are included as a separate category.[9]

How and to what extent did blacks and mulattoes move up the agricultural ladder in the antebellum South? If the complexion gap operated in the rural Upper South, mulattoes should have climbed the agricultural ladder faster than blacks and reached higher rungs more often. If white land owners believed mulattoes more capable and thus more likely to succeed as independent or semi-independent farm operators, white landowners should have been more likely to enter into a tenant relationship with light-skinned African Americans. If whites behaved in this manner, mulattoes would achieve tenant status earlier and to a greater extent than blacks. Similarly, if ownership required mortgage credit, biases among white lenders would have led them to lend more willingly to mulattoes than blacks, implying that mulatto ownership would occur earlier and in larger proportions among mulattoes than blacks.

Table 3 provides unconditional estimates of rates of farm laboring, tenancy, farmers without farms, and ownership per thousand population for each

Table 3. Farm Laborer, Tenancy, and Ownership Rates among Free African Americans by Cohort in 1860 (per thousand farm workers\operators at age and complexion) Mulattoes (M) and Blacks (B).

Age Cohort	Farm Laborers		Tenants		Farmers without Farms		Farmers	
	(M)	(B)	(M)	(B)	(M)	(B)	(M)	(B)
20–24	745	876	78	18	137	80	39	27
25–29	587	853	144	20	192	85	77	41
30–34	568	822	148	35	185	76	99	67
35–39	618	784	99	39	137	102	145	75
40–44	545	808	152	37	131	82	172	73
45–49	447	686	105	60	197	143	250	111
50–54	446	730	189	36	257	92	108	142
55–59	383	692	149	46	255	138	213	123
60–64	604	694	75	41	189	104	132	162
65–69	455	735	91	20	136	102	318	143
70–74	364	671	91	12	273	134	273	183
75–79	364	750	91	23	182	68	364	159

Notes: For definitions see Table 2 and text.
Sources: See Table 2.

complexion and quinquennial cohort.[10] These estimates reflect a notable complexion gap. At nearly every cohort after age 24, laboring rates for mulatto men are well below those of black men, often by as much as 250 per 1000 at age. Equally notable is the much more rapid movement up the ladder from laborer to tenant among mulattoes than blacks. Tenancy rates among mulattoes increased from about 78 per thousand (or 215 per thousand if we accept that farmers without farms were tenants of some sort) among mulatto men age 20–24 to 148 per thousand (or 333) at age 30–34, after which tenancy rates changed little. Black men were much less likely to rise even to tenant status. Tenancy rates among 20–24 year-olds were only 18 per thousand (or 98) at 20–24 years and rose only to 35 per thousand (or 111) at 30–34 years, at which time tenancy rates also generally stabilized.

Ownership rates also demonstrate a marked complexion gap. Mulatto men were more likely to own their own farms than black men at nearly every age. Neither blacks nor mulattoes in their twenties were likely to own a farm with ownership rates well below 100 per thousand for both groups. Mulatto men, however, were more likely to acquire their own farm in their thirties and forties.

Ownership rates among mulatto men in the 35–39, 40–44, and 45–49 cohorts were twice or more those of black men as were those of mulatto men in their late fifties and late sixties. (The smaller gap for the 50–54 and 60–64 cohorts are likely the result of relatively small numbers of mulatto men in those cohorts.)

Clearly, both blacks and mulattoes were capable of climbing the agricultural ladder. Most began at the unquestioned bottom of the agricultural ladder, as farm laborers, and many remained there throughout their lives. But many made modest strides up the ladder. For mulattoes, tenancy rates increased 140% between the 20–24 and the 45–49 cohorts. For blacks, tenancy rates increased 207%. It was in achieving land ownership, however, that mulattoes showed a definitive advantage. Ownership rates increased 640% for mulattoes between the 20–24 and 45–49 cohort; for blacks, ownership rates increased a more modest but nonetheless notable 410%.

While the evidence provided in the 1860 census is suggestive of life-cycle effects, it is not definitive. Artificially constructed cohorts, like those use here, provide a rough proxy for the actual life-cycle experiences that will be better understood only through longitudinal studies. Over the course of the nineteenth-century several things changed that may have had differential cohort effects. A brief post-Revolutionary manumission wave was gradually replaced with anti-manumission attitudes and laws designed to check the practice. Such changes surely changed the nature of manumission and freedom, changes that are not captured in this analysis. Additionally, each constructed cohort was at a different point in its life-cycle as it passed through the agricultural depression of the late 1830s and early 1840s. Passing through this period at different ages may have had differential cohort effects. Younger cohorts that came of age in the post-depression era may have found it easier to acquire property than those unfortunate enough to have passed through their mid-thirties to mid-forties (the ages at which most cohorts began buying their first firms) during the depression. Only further research, particularly true longitudinal studies, will answer these questions. One potential data source are the state tax records, which provide annual assessments on real and personal property.

A meaningful comparison with whites' ascent up the ladder in the antebellum Upper South awaits further research, but the available evidence suggests that mulattoes, despite their advantages, lagged behind whites. While Atack's (1989) and Winter's (1987) estimates are not directly comparable because they do not report on laborers and exclude farmers without farms, their results imply that blacks and mulattoes were more likely than whites to remain tenants. If Atack's methods and classifications are used instead of those discussed above, mulatto ownership rates fall well short of northern men.[11] Atack estimates ownership rates for the 20–24 cohort of northern whites at a remarkable 691 per thousand;

Upper South mulattoes achieved ownership rates of only 286 per thousand. Still, Upper South mulattoes age 45–49 realized an ownership rate of 593 per thousand at 45–49 years compared to 868 per thousand for northern whites. Certainly, southern mulattoes, no matter how privileged relative to blacks, labored under the burden of dark skin in a society structured on racism, but given the burdens they faced it is remarkable that nearly 60% of all mulatto farm operators owned their own farms. Historians, it seems, have been too quick to deny free African Americans an agency they clearly retained.

THE COMPLEXION GAP AND WEALTH ACCUMULATION

Because mulattoes were more likely than blacks to rise from farm laborers to tenants and, ultimately, to farm ownership, mulattoes also accumulated more personal property. It was not enough to acquire some real estate, either through tenancy or outright ownership. Although farm-making costs were relatively low in the long-settled Upper South, regular farm operations required farm implements, tools, animals, feed and seed inventories, and household items. For farmers, climbing the ladder was usually associated with the acquisition and accumulation of personal property as either a production or consumption complement for real property. For nonfarm rural Americans upward occupational mobility implied similar accumulations. Fortunately, the 1860 manuscript census provides data to investigate the rate and nature of personal property accumulation by the Upper South's free African Americans.

In addition to the age and occupation data previously discussed, the other critical variables reported in the 1860 manuscript censuses were real estate and personal wealth entries. Economic historians frequently use this data, but concerns are often raised about their accuracy. Moreover, many census marshals returned complete information on some households but failed to enter any value in either wealth column for others. The exact meaning of this missing data has eluded researchers. Does a missing value imply zero wealth? Does it imply very low wealth, so low that it was not worth the marshal's effort to estimate it? Does it imply that households concealed or obscured wealth from an authority figure who may have reported them to the tax collector? Or, does it imply neglect or oversight on the marshal's part? It was probably a combination of all these reasons, but the first is the most common assumption, one that may bias the results.

Sometimes, the missing observations are simply excluded from statistical analyses. But doing so is likely to impart an upward bias to wealth estimates if low-wealth households were more likely to have an unrecorded value than

middling or wealthy households. Others assume that missing observations effectively imply zero wealth holding. This assumption imposes a downward bias if unrecorded wealth values were low but nonzero. Even though Steckel (1994) found a 40% nonresponse typical, it seems unlikely that 40% of American households owned nothing. Instructions given the census marshals, however, may have induced them value and enumerate only property liable to state or local taxation rather than all property.[12] In this case $0 may have been an accurate valuation, and the marshals may have chosen to leave blanks rather than report zeros.[13]

Complementary evidence suggests that households with unrecorded wealth were low-wealth households that, in fact, owned little taxable property. As a check on the census enumerators' practices, male heads of households listed in the 1860 census in five Virginia counties were linked to that state's 1860 personal property tax lists. Although both lists ostensibly reported the same thing (the value of personal property), it was unlikely that both sources would return the same value for a given household. Virginia (1852) taxed only selected personal property, including slaves over 12 years, farm animals (the first $100 worth was exempt), carriages, watches and clocks, pianos and harps, gold and silver plate and jewellery, household and kitchen furniture, and financial assets. For those householders reporting personal property wealth in both sources, census estimates were consistently higher than taxable valuations, suggesting that census marshals included estimates of at least some property not subject to taxation.

The more interesting cases, however, are those households with no wealth estimates recorded in the census that nevertheless appear in the personal property tax lists. Of 227 such cases, 183 had no taxable personal property. Eight were assessed on $10 or less. Twenty-five householders were assessed on values between $11 and $25; eight others on less than $50 in taxable personalty. Although this implies that unrecorded observations in the census represent low values, it does not necessarily imply zero personal wealth. It must also be kept in mind that a zero personal property assessment did not imply zero personal property ownership. In Virginia, clothing, live stock worth less than $100, and an uncountably finite number of other goods were not subject to state tax. Moreover, census enumerators (and tax assessors, for that matter) may not have estimated modest holdings. Thus unreported personalty data should not be taken to imply $0 in actual property ownership, though it is likely that census enumerators censored at the low end of the wealth distribution. That is, they failed to report small or, perhaps, hard to value holdings.

Although plausible explanations can be constructed for the missing data, the issue at hand is that missing data makes statistical inference problematic,

especially when familiar least-squares or maximum likelihood methods are used. Recent research by Conley and Galenson (1994, 1998) offers a reasonable estimation alternative to ordinary least squares (OLS), namely quantile or least absolute deviation (LAD) methods. Because such a large percentage of households (regardless of nativity and residence) appear in the census without personal property estimates, the use of OLS or maximum likelihood methods create several problems. First, regardless of sample size, the estimated coefficients will be biased and inconsistent. Second, most wealth studies employ semi-logarithmic regression specifications, which require imputation of some positive value for zero and unrecorded wealth values to make the logarithmic transformations possible and, as Conley and Galenson (1994, p. 155; 1998, p. 474) demonstrate, coefficient estimates differ depending on the exact imputation.

A third shortcoming of OLS or ML estimation, even if it produced unbiased and consistent estimates, is that the conditional mean of the wealth distribution may not be the most useful or informative statistic. Wealth and income studies are instructive when they inform about wealth at several different quartiles, deciles, or centiles. It is common, in fact, for studies like those of Buchinsky (1994), Katz (1998), and Goldin and Katz (1999) to highlight the gap between the highest and lowest deciles or quartiles. LAD or quantile regression can simultaneously deal with missing or censored data and allow for direct computation of different centiles, deciles, or quartiles depending on the researchers' needs and the quality of the underlying data.

Intuitively, the purpose of either LAD or OLS regression is the same, namely to describe the central tendency of the data.[14] OLS estimates the mean of the dependent variable, conditional on the values of the independent variables. LAD techniques, on the other hand, estimate the median (or any other centile) given the values of the independent variables. Median (0.5 quantile) regression estimates a hyperplane through the data that minimizes a weighted sum of the absolute residuals rather than one that minimizes the sum of the squared residuals. More formally, if we define $e_i = y_i - \Sigma_j \beta_j x_{ij}$. The familiar OLS solution is to minimize $\Sigma e_i e'_i$ with respect to the β's. LAD estimation, on the other hand, minimizes $\Sigma_I \mid e_i \mid w_i$, where $w_i = 2q$ if $e_i > 0$ or $2(1 - q)$ if $e_i \leq 0$. The STATA "qreg" command calculates the weights appropriate to the specified percentile (or quantile) and solves the minimization problem using a linear programming algorithm.

The theory of LAD actually predates OLS, and recent research has shown that LAD has several advantages under certain conditions.[15] Brown (1985, p. 418) notes that median-based procedures are more resistant to a breakdown of basic assumptions than are mean-based procedures, making LAD particularly attractive in the presence of large outliers. A related advantage of LAD's

robustness properties, is that LAD procedures can be used to deal with missing observations, where missing data is replaced by arbitrary values that can be varied to yield bounds on significance levels. A third, a particularly useful feature, is that the procedure is easily generalized to estimate quantiles other than the median. If we want to estimate the 85th percentile, an appropriate set of weights are devised so that 85% of the residuals are negative. Thus, LAD estimates are robust to outliers (which we have), missing observations (which we also have), and can generate estimates of wealth at different points in the distribution. In particular, it can estimate the coefficients of a regression so long as that line lies completely above or below the censoring point. OLS regression cannot, so its results depend on the exact censoring point (see Conley & Galenson, 1994, 1998 for a more complete description of this problem).

Despite its potential advantages, LAD estimation should not necessarily be viewed as the single best solution to the data problems inherent in the use of census information. LAD estimates require significant computing power and multiple regression procedures awaited the implementation of computer-powered linear programming algorithms developed in the 1970s. A second disadvantage is that LAD estimation procedures can, except under very stringent conditions, generate nonunique solutions.[16] A third disadvantage of the procedure actually follows from one its advantages: although LAD procedures place little weight on large residuals (outliers), it weights very small residuals heavily (Emerson & Hoaglin, 1983, pp. 189–190). Finally, it must be remembered that quantile regression does not really solve the censoring problem, except by focusing on points in the wealth distribution above the censoring point. This may or may not interesting (it is in the present case), but it still does not allow us to discuss the effect of a given variable on the entirety of the wealth distribution because the entire distribution is not accurately or wholly observed. In short, though LAD methods are less sensitive than OLS methods to missing or censored data, the missing data problem is still not completely resolved.

Before estimating LAD regressions, it was necessary to assign values to the missing personal property data cells. The available data was used to predict a likely censoring point.[17] Table 4 reports the frequency distribution of personal wealth for black and mulatto households. It is readily seen that a majority of southern free African Americans owned less than $500 in personal wealth, and many had accumulated less than $100. There were, however, a handful of extremely wealthy individuals. Edwin Turpin, a 70-year old mulatto man of Goochland County, Virginia, was the wealthiest person in the sample with $29,500 in reported personal wealth. It is also readily seen that about 38% of householders returned no personal wealth information whatsoever.

Table 4. Frequency Distribution of Personal Wealth by County Free African Americans in 1860.

	Personal Wealth ($)								
County	5	10	25	50	100	500	1000	1000+	NA
Anne Arundel, Md	1	0	6	100	164	89	7	4	437
Caroline, Md	0	0	2	23	30	92	8	2	283
Dorchester, Md	23	208	236	99	74	150	38	6	50
Frederick, Md	1	11	66	75	53	46	4	0	275
Harford, Md	2	4	125	129	80	72	4	1	89
Kent, Md	0	0	51	123	76	63	11	1	182
Prince Geo, Md	0	0	1	4	8	17	1	2	139
Talbot, Md	0	0	13	48	40	57	1	3~	291
Accomack, Va	3	47	167	74	31	31	1	1	169
Campbell, Va	0	15	42	62	18	45	4	4	32
Fauquier, Va	1	6	14	36	30	21	6	1	6
Goochland, Va	0	0	5	12	15	11	0	2	72
Northampton, Va	2	9	22	46	15	13	2	0	59
Northumberland,Va	0	0	0	1	3	11	0	0	21
Southampton, Va	7	34	54	25	11	4	2	2	191
Stafford, Va	0	1	7	14	6	4	1	1	21
Warren, Va	6	8	12	4	5	3	0	0	1
Craven, NC	1	2	48	48	34	32	2	2	145
Edgecomb, NC	0	0	0	3	6	13	1	1	48
Halifax, NC	10	40	110	93	66	82	5	0	122
Robeson, NC	2	8	28	36	29	45	1	8	80
Bath, Ky	0	0	0	0	4	6	0	0	15
Franklin, Ky	0	3	7	6	14	17	3	1	43
Claiborne, Tn	0	0	1	4	11	9	3	0	2
Baton Rouge E, La	0	0	0	4	5	29	6	8	21
Totals	59	396	1,017	1,069	828	962	111	50	2,794

Source: See Table 1.

Although the exact censoring point cannot be determined unambiguously, the data provide some very good clues. Marshals in Dorchester County, Maryland and Fauquier and Warren, Virginia were particularly vigilant, recording wealth estimates for 94.5% of enumerated households. Comparisons of the frequency distributions of these three counties with the remaining 23 reveal that most censoring occurred at the low end of the distribution. In Dorchester, Fauquier, and Warren counties, 2.8% of households held $5 or less in personalty compared to only 0.5% in the other 23 counties. Censoring was even more pronounced at slightly higher wealth levels. In the three counties, 21.3% of households

returned $6–$10 in wealth; 25.1% returned $11–$25, compared to 2.7 and 11.9% in the other 23 counties. The likelihood of enumerator censoring increased at the low end of the wealth distribution, particularly for holdings of less than $10. Based on this low-end censoring, quantile regressions were estimated assuming the censoring point was $2, $5, or $10.[18]

LAD regressions included several variables likely to influence the pattern of personal property accumulation. Age and its square were included as independent variables because extensive research by labor historians has shown that wealth accumulation over a lifetime is largely consistent with the well-known life-cycle hypothesis. That is, during their teens and twenties, young people tend to go into debt accumulating human capital and have correspondingly modest wealth. Toward the middle years, debts are repaid, returns on human capital investments are realized, and wealth is accumulated relatively quickly. Then in old age, wealth decreases as assets are depleted to finance retirement or divested as intergenerational transfers. The life-cyle pattern typically manifests itself as an inverted U-shaped age-wealth profile. Because rural Upper South African Americans are commonly portrayed as children of poverty, they probably received few and modest intergenerational transfers so that twenty-year-olds should have few assets. Moreover, restrictions on educating African Americans meant limited human capital accumulation except for apprenticeships in a few semi-skilled and skilled occupations, and relegated most to a lifetime of backbreaking labor and an inability to amass great personal wealth. Still, we expect that pattern to hold. Even poor people accumulate as they age, though clearly not as much or as rapidly as wealthier individuals.

If a complexion gap operated in the rural Upper South, more mulattoes than blacks should have been better able to rise above the ranks of manual laborer. And, in fact, mulattoes were less likely than blacks to report their occupation as laborers (see Table 1). Mulattoes and blacks were about equally likely to obtain work as seamen. Mulattoes were more likely to acquire skills and report a skilled occupation, or a mercantile or professional employment. Moreover, as the previous section made clear, mulattoes were more likely to become farm tenants and farm owners. Thus occupations are divided into ten broad categories and included as independent regressors. To capture any effects of the complexion gap beyond its direct influence on an individual's ability to acquire human capital or follow an occupation a separate dummy variable (BLACK) was included to capture the effect. It is expected that the coefficient will be negative and both statistically significant and economically meaningful.

A family size variable equal to the number of people residing in the household was also included in the regression. It is not clear a priori how household or family size might affect wealth accumulation. On one hand, larger households

may have been capable of putting more people to work, improving the family's ability to accumulate. On the other hand, households may have had larger numbers of unproductive members, namely the very young or the elderly, which may have inhibited wealth accumulation.[19]

Finally, dummy variables for state of residence were included to capture any state-specific effects on an individual's ability to accumulate property. Most southern states passed laws attempting to limit the geographic mobility of African Americans. Others passed laws barring African Americans from certain occupations. Both sorts of laws certainly restricted African-American advance if jobs and incomes demonstrated noted geographic or sectoral shifts. The dummy variables should capture the impact of different laws and customs as well as differential enforcements of similar laws (such as nonimmigration laws).

Based on the availability of data and the likelihood of low-end censoring, quantile regressions were estimated for $2, $5, and $10 censoring points (because of their similarities at upper quantiles, only the $2 censoring point regressions are reported). Regressions were estimated in semi-log form (the dependent variable is the natural log of personal wealth). Parameter estimates for selected quantiles as well as OLS estimates for comparative purposes, are reported in Table 5. Most of the estimates accord with prior expectations.

For both men and women, the age-wealth profile exhibited the usual pattern of increasing at a decreasing rate up to age 55 or 60 and then turning down after age 60 at some quantiles. As expected, farm owners of both genders held significantly more wealth than unskilled laborers. A 40 year old mulatto male farmer at the 75th quantile, for example, owned $260 more than an mulatto male laborer; a 40 year old mulatto female farmer at the same quantile owned $220 more than a mulatto female laborer, holding all else constant. Not surprisingly, among males, watermen, skilled artisans, and merchants/professionals amassed significantly more property than unskilled laborers.

The female occupation coefficients reveal some surprising effects. Domestic servants and washerwomen, for instance, are often believed to have been unskilled workers who eked out a bare subsistence at the margins of southern society. Regression estimates fly in the face of that belief. At most estimated quantiles, domestic servants, washerwomen, and seamstresses accumulated significantly more property than laborers. Though domestic service and washing were hardly skilled occupations, engaging in them implied a greater ability to accumulate property than having no particular occupation. African American women working in service occupations (principally, nurses, midwives, and boarding house operators) also accumulated significantly more than unskilled women.

The regressions also reveal some important regional effects in wealth accumulation. African American men living in Louisiana and Tennessee acquired

Table 5. Quantile and OLS Regression Estimates, Selected Quantiles Dependent Variable = natural logarithm of personal wealth, Householders age 20–75, $2 censoring point.

	Quantile					
	0.95	0.85	0.75	0.60	0.50	OLS
			Men			
Age	0.05*	0.07*	0.06*	0.06*	0.04*	0.06*
	(2.33)	(5.66)	(5.14)	(4.96)	(3.02)	(4.80)
Age^2	–0.00*	–0.00*	–0.00*	–0.00*	–0.00*	–0.00*
	(–1.70)	(–4.64)	(–4.24)	(–4.01)	(–2 22)	(–3.77)
House	0.07*	0.67*	0.88*	0.09*	0.09*	0.07*
	(4.88)	(7.24)	(9 64)	(9.55)	(8.17)	(7.85)
Laborer	–0.15	–0.00	0.24*	1.80*	1.84*	0.51*
	(–1.25)	(–0.03)	(3.02)	(20.57)	(19.22)	(6.37)
Farmer	1.45*	1.58*	1.93*	3.74*	4.01*	2.71*
	(9.42)	(16.68)	(20.37)	(36.81)	(36.11)	(29.01)
Waterman	0.75*	0.29*	0.54*	2.25*	2.49*	1.27*
	(2.85)	(1.74)	(3.29)	(12.47)	(12.58)	(7.61)
Skilled	1.03*	1.06*	1.21*	2.83*	3.02*	1.58*
	(5.61)	(9.12)	(10.33)	(22.65)	(22.20)	(13.84)
Merchant	2.21*	2.31*	1.79*	3.34*	3.38*	2.11*
	(4.73)	(7.11)	(5.70)	(9 57)	(8.76)	(6.41)
Black	–0.19*	–0.15*	–0.09	–0.09	–0.06	–0.05
	(–1.78)	(–2.30)	(–1.31)	(–1.27)	(–0.85)	(–0.84)
Virginia	–0.38*	–0.48*	–0.42*	–0.21 *	–0.04	–0.53
	(–3.84)	(–7.63)	(–4.15)	(–2.96)	(–0.46)	(–0.82)
N Carolina	–0.26*	–0.41*	–0.32*	–0.28 *	–0.23 *	–0.11
	(–2.05)	(–5.17)	(–4.15)	(–3.37)	(–2.48)	(–1.47)
Tennessee	1.14*	1.31*	1.20*	1.36*	1.55*	1.99*
	(6.56)	(3.74)	(3.16)	(3.23)	(3.37)	(5.02)
Kentucky	0.51*	0.13	0.14	–0.14	–0.25	–0.11
	(1.78)	(0 69)	(0.70)	(–0.63)	(–1.07)	(–0.54)
Louisiana	1.08*	0.36	0.77*	1.16*	1.31*	1.10*
	(3.30)	(1.37)	(2.99)	(3.96)	(4.03)	(4.00)
Constant	3.78*	2.63*	1.91*	–0.39	–0.45	0.28
	(8.84)	(10.13)	(7.24)	(–1.39)	(–1.49)	(1.08)

	Quantile				
	0.95	0.85	0.75	0.60	OLS
			Women		
Age	0.02	0.04*	0.07*	0.03*	0.05*
	(0.96)	(2.33)	(3.83)	(1.67)	(2.95)
Age^2	0.00	0.00*	0.00*	0.00	0.00*
	(–0.43)	(–1.91)	(–3.35)	(–1.33)	(–2.31)
House	0.07*	0.08*	0.02	0.00	0.02
	(3.26)	(5.25)	(1.06)	(0.24)	(1.18)

Table 5. Continued.

	Quantile				
	0.95	0.85	0.75	0.60	OLS
			Women		
Laborer	–0.17	0.03	0.09	1.75*	0.50*
	(–1.37)	(0.39)	(1.06)	(20.05)	(6.07)
Farmer	1.82*	1.92*	2.00*	3.73*	2.49*
	(6.39)	(10.20)	(10.17)	(18.69)	(13.16)
Domestic	1.00*	0.64*	0.82*	2.20*	0.74*
	(4.35)	(4.20)	(5.03)	(13.32)	(4.73)
Seamstress	0.45	0.23	0.65*	2.22*	0.90*
	(1.34)	(1.07)	(2.84)	(9 10)	(3.85)
Washer	0.32*	0.44*	0.71 *	2.24*	0.88*
	(1.99)	(4.43)	(6.63)	(20.58)	(8.50)
Service	1.53*	1.60*	1.85*	3.28*	2.12*
	(4.37)	(7.32)	(7.69)	(13.66)	(9 13)
Spinster	0.13	0.33	0.64*	2.50*	1.29*
	(0.34)	(1.26)	(2.20)	(8 60)	(4.60)
Black	-0.22*	-0.43*	-0.36*	-0.11	-0.22*
	(–1.65)	(–5.00)	(–3.85)	(–1.16)	(–2.50)
Virginia	–0.15	–0.28*	–0.06	0.25*	0.19*
	(–1.31)	(–3.63)	(–0.68)	(2.93)	(2.33)
N. Carolina	–0.14	–0.29*	–0.40*	–0.15	–0.28*
	(–0.82)	(–2.58)	(–3.36)	(–1.29)	(-2.50)
Tennessee	0.36*	0.55	0.75	1.22*	1.15*
	(1.65)	(1.36)	(1.60)	(2.44)	(2.37)
Kentucky	0.44	0.80*	0.21	–0.15	–0.01
	(1.20)	(3.65)	(0.85)	(–0.61)	(–0.06)
Louisiana	3.80*	2.37*	2.24*	3.67*	1.86*
	(10.16)	(8.81)	(7.69)	(12.12)	(6.48)
Constant	3.42*	2.84*	1.81*	0.22	0.51
	(6.06)	(8.15)	(4.88)	(0.58)	(1.42)

Notes: *t*-statistics in parentheses. STATA cannot estimate 0.5 quantile for women because regression lines falls below censoring point. Excluded variables are Maryland residence and unknown occupation. Household size evaluated at the mean. N = 5,117 for men; 1,730 censored. N = 2,022 for women; 976 censored. * = signficant at 10% or higher.

significantly more personal property than men living in Maryland. Men living in Virginia and North Carolina, on the other hand, amassed significantly less property at nearly every quantile than Maryland men. Household sizes were

also significant determinants of wealth accumulation. The positive coefficients suggest that larger households had more individuals bringing income into the household.

The regressions also reveal that blacks acquired significantly less personal wealth than mulattoes.[20] Table 6 reports the predicted wealth holdings by complexion and gender at selected quantiles, assuming they were 40 years old and operated a farm, either as owner or tenant. The complexion gap was large indeed at the upper end of the distribution. At the 95th quantile, black men had about 83% of the personal property of mulatto men. The complexion gap was similar down to the 85th quantile. At the 75th quantile and below, black men had about 92% of mulatto wealth. At the median, black wealth increased to about 93% of mulatto wealth, which is consistent with the gap at the conditional mean shown in the OLS and robust regression results. Both OLS and robust regression estimates place black wealth at about 95% of mulatto wealth. The advantage of quantile regression thus becomes clear. At the conditional median and conditional mean, wealth was similarly distributed. At the upper end of the wealth distribution, on the other hand, mulatto men had significantly more property than black men. The table also reports the unconditional mean as well as three quantiles, showing the advantages of quantile regression.

Among female-headed households the complexion gap takes a form somewhat different than that found among male-headed households. At the 95th quantile, black households had 80% of the wealth of a mulatto, female-headed household. At the 85th quantile, black wealth fell to 65% of mulatto wealth; at the 75th, black household wealth rose to about 70% of mulatto wealth. At the 60th quantile, it rose to about 88%. At the conditional mean of the wealth distribution (OLS and robust regression estimates), the complexion gap also demonstrates an especially marked gender gap. Whereas the complexion gap nearly disappeared among men at the mean, it remained at about 20% among women.

Despite mulatto women's ability to accumulate more personal wealth than black women, mulatto women lagged behind mulatto men, even black men. Table 6 shows the gender gap in wealth accumulation. At every quantile, male-headed households had more personal wealth than female-headed households. At the 95th quantile, for example, households headed by mulatto women had 65% of the personal wealth owned by mulatto men. At the 60th quantile, female-headed households had about half as much personal wealth as male households. OLS estimates show that the 50% gap persists among black women; mulatto women had about 60% as much as mulatto men.

Thus, the empirical analysis of data included in the 1860 population manuscript census implies a complex social hierarchy based on gradations in

Table 6. Predicted Personal Wealth of 40 Year-Old Black and Mulatto Farmers at Selected Quantiles.

Quantile	Mulatto Men	Black Men	Mulatto Women	Black Women
0.95	$856	$708	$555	$443
0.85	526	452	457	297
0.75	320	293	259	181
0.60	218	200	105	94
0.50	184	172	–	
OLS	121	115	78	62
Robust Regression	142	136	90	73
Unconditional Means and Quantiles				
Mean	203	145	164	67
Median	75	50	50	25
0.75	200	150	100	50
0.90	650	500	650	200

Notes: Calculated from regression coefficients reported in Table 5. Farmers defined to include farmers, planters, plantresses, and tenants. Assumes 40 year-old Maryland resident, and farmer. All other variables except constant and black set equal to zero. Household size evaluated at mean. Robust regression weights OLS residuals to correct for outliers. See STATA *Reference Manual* for description of robust regression (rreg) procedures.
Sources: See Tables 1 and 5.

skin color. At the upper end of the wealth distribution, light-skinned mulattoes of both genders demonstrated a greater ability to accumulate property than dark complected blacks. Moreover, the complexion gap reinforced a gender gap. Mulatto women, though clearly more able to acquire more property than black women, still lagged well behind black men at most points in the wealth distribution. In fact, the gender gap was wider around the mean and the median of the distribution than at the upper tail. In the antebellum rural South both the complexion gap and the gender gap were evident, and black women householders resided at the lowest rung on economic ladder.

CONCLUDING REMARKS

Using data reported in the 1860 federal census, empirical analysis reveals an unmistakable complexion gap in the antebellum rural Upper South. The analysis, nevertheless, provides lower bound estimates of the gap due to the possible underreporting of mulattoes as blacks. More accurate data would strengthen the

empirical analysis and likely result in an even wider gap. Generations of historians have documented this gap in urban centers in the Lower South, but doubted its presence in the rural Upper South. The evidence presented above overturns this long-held interpretation. Rural mulattoes were more likely to become farm tenants and farm owners than blacks who, disproportionately, remained on the lowest rung of the agricultural ladder. Rural mulattoes also accumulated more personal property than blacks at every point in the upper half of the wealth distribution. Limited evidence on the lower half of the distribution suggests that the poverty was more colorblind than affluence, but that does not alter the reality that mulattoes were more likely than blacks to climb out of poverty.[21] Historians may have doubted or overlooked this complexion gap in the rural South because these men and women were not politically active, nor did they form the same types of social clubs found in Charleston, Savannah, and New Orleans. Racism ran deep in rural America, and the best strategy in rural areas may have been to quietly exploit available opportunities without drawing too much attention to one's self.

It is also heartening that complexion gap found here is in general agreement with evidence of a more general mulatto advantage. Margo and Steckel (1992) found that light-skinned ex-slaves recruited into the U.S. Army during the Civil War were significantly taller than dark-skinned recruits. They attribute this effect to a combination of heterosis and preferential treatment accorded light-skinned slaves. Komlos (1992) and Bodenhorn (1999a, c) found a similar pattern among the Upper South's free African Americans. While the exact connections between the economic and the "biological" standard of living are not yet fully understood, nor culturally or temporally invariant, there is a general correspondence between wealth (or income or socioeconomic status) and height in many historical and modern societies. The findings of this paper accord with the anthropometric results. Not only were light-skinned mulattoes taller than blacks, they were wealthier.

Evidence about how blacks and mulattoes fared relative to contemporary whites residing in the South awaits additional research, but comparisons to whites living in the northern cities suggests that southern mulattoes fared reasonably well by contemporary standards. Conley and Galenson (1998, p. 482) estimated that, at the 90th quantile, a skilled 40 year-old, American-born man living in Boston accumulated $1,562 in personal wealth, about twice that of a rural, southern, mulatto farmer. That same mulatto farmer, however, had accumulated about $130 more than a skilled 40 year-old, white American-born man residing in Indianapolis. At the 75th quantile, a hypothetical mulatto farmer owned about the same amount of personalty as a skilled, white, American-born male living in New York City and Chicago. Clearly, comparisons of southern

African Americans and northern whites are not the most informative sorts of comparisons, but they do imply that the mulatto advantage in the antebellum South was substantial indeed.

This article nearly begs more questions than it answers. In the face of much qualitative evidence, historians have accepted the existence of a complexion gap within the African American communities of the urban Lower South. It is now time to determine, with some precision, the quantitative extent of that gap. Only by doing so will we fully comprehend whether the gap found here reflected cultural, social and economic attitudes throughout the South or whether it was unique to the rural Upper South. Ultimately, understanding the mulattoes' actual place in southern society will depend on determining the life-cycle pattern of real and personal property accumulation among rural and urban southern whites. Comparisons to northern whites, while informative, do not illuminate the complex social heirarchy that arose in the antebellum South. Comprehending the complexities of race in southern society requires much additional inquiry. This article represents only a first step on a potentially rewarding research endeavor.

NOTES

1. Komlos (1992) and Bodenhorn (1999a, c) find that light-skinned African Americans were taller than blacks. For those unfamiliar with the methodology and basic findings of historical anthropometry, good introductions are Steckel and Floud (1997) and Komlos and Cuff (1998).

2. Johnston (1970) reports several other similar cases.

3. This reporting bias may strengthen the results reported below if census marshals, in fact, identified only the lightest African American as mulattoes. To the extent that complexion preferences operated, they should have been strongest for the lightest complected.

4. For an explanation of the sampling procedure see Bodenhorn (1999b).

5. The $0.80 head tax was potentially quite onerous. It implied that a 21 year old African American owning no taxable property whatsoever was forced to pay a tax equivalent to that paid by William R. Fleming, a white man living in Goochland County, who was taxed 80 cents on three hogs (worth $10), seven head of cattle ($85), one clock ($5), and other household furnishings ($150). Virginia (1860).

6. The five counties are Accomack, Campbell, Fauquier, Goochland, and Stafford. Not all county personal property tax lists are available because the Library of Virginia's microfilming project is not yet complete. Female-headed households are excluded because the state taxed only males and male-headed households.

7. Even with explicit enumeration of land tenure in postbellum censuses, agricultural and economic historians still debate the exact meaning of the terms employed by census enumerators. Alston and Kauffman (1998) and Irwin and O'Brien (1998, 1999) offer recent reinterpretations based on alternative definitions of seemingly straight-forward

terms. A close reading of the literature reveals that interpreting the manuscript censuses is as much art as science.

8. Gray (1933), Ransom and Sutch (1977), and Owsley (1949) offer versions of the traditional interpretation.

9. Houdek and Heller (1986) argue that even the most liberal definition of tenants based on manuscript census labels probably underestimates the extent of tenancy in 1860.

10. It should be noted that these statistics do not account for state of residence, age, or time since manumission. Estimates of wealth accumulation, provided below, account for the two former effects. The latter is not known and cannot be determined.

11. Atack (1989), Table 2, ignores laborers and farmers without farms and creates three categories: tenants, part-owners, and owners. Part owners are cases where farm value in the agricultural census exceeded real estate holdings enumerated in the population manuscript. Atack's belief is that these men farmed their own property and leased or tenanted additional acreage.

12. Marshals were instructed to estimate the value of property as assessed for taxation after adding "the proper amount to the assessment, so that the return should represent as well the true intrinsic value" since assessed values were often below market values. U.S. Census Office (1862, p. 79). It is possible, however, that census estimates include more than taxable property. At another place, marshals were instructed to estimate and record the value of all personal property, which was "to include the value of all property, possessions, or wealth of each individual which is not embraced in the column previous [real estate], consist of what it may; the value of bonds, mortgages, notes, slaves, live stock, plate and jewels, or furniture; in the fine the value of whatever constitutes the personal wealth of individuals" (Conley & Galenson, 1994, p. 149). Even this alternative instruction closely accords with the list of taxable property in Virginia, so Virginia marshals may have estimated only taxable property rather than all personalty.

13. One enumerator in Virginia recorded 4 zeros in the personal wealth column in addition to leaving many others blank.

14. This and subsequent paragraphs describe quantile regression in an intuitive manner. Those interested in the details and the mathematical derivations should see Koenker and Bassett (1978), Buchinsky (1994), Brown (1985), Emerson and Hoaglin (1983), and STATA (1995).

15. Koenker and Bassett (1978) discuss Laplaces's LAD derivation dating to 1818.

16. The STATA qreg procedure warns the user when alternative solutions exist at a given iteration. In the present case, the warning was returned in only a few instances, mostly in the estimation of quantiles near the censoring point.

17. Conley and Galenson (1998) used the lowest reported value. In this case, two enumerators actually returned a value of $0 for a handful of households, even while they provided several dozen missing observations. Thus it seems unlikely that $0 was the actual censoring point.

18. The regression parameters were estimated by substituting the censoring point for the missing data points. Conley and Galenson used a slightly different method, but Conley (private correspondence 7 July 1999 and 17 August 1999) believed that my method is appropriate so long as the estimated centile did not fall below the censoring point for any observation. Because only centiles in the upper half of the distribution are estimated, this is unlikely to have occurred. As expected, the STATA qreg algorithm returned parameter estimates for lower quantiles when the lower censoring points were

used. At very low quantiles (i.e. 0.4 and below), however, the procedure returned parameter estimates but no significance levels, implying that the quantile fell below the censoring point. Parameter estimates at the upper quantiles were little affected by altering the censoring point. The $5 and $10 censoring points were chosen based on evidence in Table 4. The $2 censoring point was used because several marshals each reported a handful of $2 estimates.

19. Two additional variables often included in such regressions – literacy and mobility – were not included. First, very few free African Americans were recorded as literate. It may have been that very few were literate, or it may have been that census marshals, knowing that it was against the law to educate free blacks, simply did not bother to ask them if they were literate. Mobility was excluded because state laws prohibited interstate migration (laws which may not have been fully obeyed) and because most census marshals recorded state of birth, not county, so that intrastate migration (that most likely among free African Americans) is unknown.

20. Historians familiar with postbellum censuses have sometimes argued that census enumerators were more likely to label wealthier African Americans as mulattoes regardless of their actual complexion or heritage. If true, this would produce spurious results when regressing complexion on wealth. To check for this possibility, probit regressions were estimated with complexion as the dependent variable. Independent regressors included all those used in Table 5 plus the natural logarithm of personal wealth. For male-headed households, the estimated wealth coefficient was small and insignificant at usual levels [p value of 0.29]. For female-headed households, the coefficient was also small and insignificant [p value of 0.19]. It seem unlikely that the regression results are spurious. I thank Anthony O'Brien for reminding me of this concern among historians of the postbellum South.

21. Estimates of wealth holding among men at the 40th quantile suggest no statistical difference between blacks and mulattoes.

ACKNOWLEDGMENTS

I thank Tim Conley, Stanley Engerman, Farley Grubb, James Irwin, Whittington Johnson, Kyle Kauffman, Sumner LaCroix, Robert Margo, Michelle McLennan, Carolyn Moehling, Anthony O'Brien, Joel Williamson and two anonymous referees for comments on a previous draft. Financial assistance from the Robert King Mellon Foundation, the John M. Olin Foundation, the Economic History Association, and Lafayette College is gratefully acknowledged.

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A CAPITAL INTENSIVE INNOVATION IN A CAPITAL-SCARCE WORLD: STEAM-THRESHING IN NINETEENTH CENTURY ITALY

Giovanni Federico

ABSTRACT

The Italian agriculture in the 19th century enjoyed a quite poor reputation among historians, for its innovative record. This article deals with a possible counterexample, the wide diffusion of steam threshing since the 1870s. It was a highly capital-intensive machine, and thus its success seems to contrast with the scarcity of capital, which plagued the Italian agriculture. Indeed, the pattern of diffusion in time and space was influenced by the cost of capital, but the constraint was eased by outsourcing. Steam-threshers were owned by specialised entrepreneurs and rented to farmers and landowners. This successful institutional arrangement casts a lot of doubt on the negative effects of the alleged institutional rigidity on technical change.

Advances in Agricultural Economic History, Volume 2, pages 75–114.

ISBN: 0-7623-1001-4

1. INTRODUCTION: THE MECHANISATION OF ITALIAN AGRICULTURE

Agriculture does enjoy a poor reputation among historians of Italian development (Cohen & Federico, 2001). According to the available (and highly controversial) figures, the rate of growth of agricultural output from the Unification of the country in 1861 to 1938 was a paltry 0.7% p.a. (Ercolani, 1969). This poor performance dragged down the growth of the whole economy. Historians blame the failure to exploit the available opportunities of technical progress – i.e. to imitate the "best" (British) practice. High-farming was adopted only in the Po Valley, and mechanisation was very slow. On the eve of World War I, there were only 12,500 horse-driven reapers in the whole country, almost one century after their first appearance in the USA, and tractors spread only after World War II (UMA, 1968). The blame rests squarely on the "institutions" – i.e. on the power of the ignorant, lazy and risk-avert landlords who exploited ruthlessly the poor peasants, and feared that any innovation could endanger their social status.

This conventional wisdom has been challenged of late by several scholars. They have pointed out that many innovations: they were not suited to the Italian environment and factor endowment (Galassi, 1986, 1993; Corona & Masullo, 1989). The British varieties of grass could not stand long, dry summers, and were unsuited to soil in most of the peninsula. The hilly terrain, and the ubiquitous presence of vines, mulberries, olive and other fruit trees made the use of machines designed for the Midwest plains very difficult. Furthermore, as reminded many years ago by Dowring (1965), labour saving, capital-intensive techniques were unsuited to labour-abundant countries, such as Italy. Suitable innovations, such as fertilisers did spread quite fast since the end of the 19th century (Pezzati, 1993). So far, however, the debate has relied mainly on experts' statements and other anecdotal evidence. The data are admittedly scarce, but not totally absent.

This article deals with the adoption of a specific innovation, the steam thresher. The case is especially interesting because the machine was apparently wholly unsuited to the Italian conditions. It used steam in a country without coal (Bardini, 1998). It was a bulky and expensive piece of equipment, subject to substantial scale economies, while farms in Italy were rather small and allegedly starved of capital. Last but not least the steam thresher competed with other, simpler and cheaper, machines. Yet it was a success-story, as the Inchiesta Jacini, the great survey of the conditions of Italian agriculture in the 1870s and 1880s shows. For instance the volume for in Emilia remarks that "the adoption of tools and machinery is quite limited . . ., but for the steam threshers, which

have been introduced not without troubles at the beginning but now quite successfully".[1] How is possible to explain this success? Why did peasants and landowners opt for mechanising threshing well before harvesting or any other operation? And why did they choose steam instead of horse power?

The paper begins with a description of the available techniques, including some evidence on their costs (Section 2). The following section deals with the situation in the late 1880s, on the basis of a very detailed official source, the *Statistica delle Caldaie a vapore* (henceforth Statistica, 1890). Section 4 frames that snapshot in the long-term growth of mechanical threshing in Italy, with some comparison with other countries. Section 5 tests a simple econometric model of diffusion in time and space. Section 6 puts forward an "institutional" explanation of the success of steam threshing. Finally, Section 7 sums up the results and sketches out the implications for the broader issues of technical progress and rationality in Italian agriculture.

2. THRESHING: A SHORT TECHNICAL OVERVIEW

Threshing is the final stage of the production of wheat and other cereals. The grains are separated from husk and straw, before being sent to milling (or otherwise utilised). This operation can be performed almost any time, provided that the wheat is dry. In humid climates with a late harvest, as in North Europe and USA, the cereals were stored in barns and threshed during the slack season. In the Mediterranean countries, wheat was harvested in June, early July and threshed immediately after. The risk of heavy rainfall, which could spoil the grain, was small, even if not negligible, while the system saved substantial amount of capital. Storing grains instead of the whole wheat shocks reduced the needed size of the barns by almost two thirds, the proportion of husk and straw out of the total weight of the crop.

For centuries, cereals had been threshed by hand or by animal (Giacomelli, 1864; Herve-Mangon, 1875; Cencelli-Lotrionte, 1919; Cei, 1913; Niccoli-Fanti, 1924; Rogin, 1931). Men either slammed the stocks on a table ("al banco") or beat them with a flail ("correggiato") when lying on the ground. Horses or oxen threshed the cereals either by treading over them or pulling heavy rolls, stones etc. Then the grains were tossed into the air in windy days to winnow them. These traditional methods were very physically demanding, for men and animals, and so there was a strong incentive to mechanise them (Daumas, 1968; Wik, 1953; Rogin, 1931; MacDonald, 1975; MacClelland, 1997). After several attempts, the first working machine was invented in 1786 by a Scotsman, Meikle. It consisted of "a drumlike beater revolving inside a set of concaves to knock out the grain from the heads" (Wik, 1953, p. 16). The first threshers

were fixed and powered by horses. In the following years, the size of the machine was reduced to make it movable (portable) and/or powered by men (with a crank or pedals).

Steam was first introduced in the 1830s, in fixed plants.[2] The first portable steam thresher was built in 1841 by "Ransomes", a British firm which was to became a major supplier of machines all over the world. The original ("simple") machines only threshed, and sometimes winnowed, the wheat. They thus needed a large crew to feed the machine, take away and bind the straw, clean the wheat from impurities etc. Since then, the steam thresher was substantially improved: the most advanced models of the late 19th century were entirely mechanised, and produced clean grain, which had only to be stored away.

In the 1910s, steam began to be substituted by the internal combustion engine, further reducing the size of the machine. It was thus possible to build combined harvesters – which reaped and threshed at the same time.[3] There had been several experiments with steam-powered harvesters, but with little practical success, perhaps because the machines were deemed too dangerous. The sparks from the engine would have set fire to the whole field. Actually, steam threshing itself was quite an hazardous task. The boiler and the threshing machine were usually kept apart, but in spite of this precaution, fires were common and sometimes claimed lives (Wik, 1953, pp. 138–139; Isern, 1981; Adelman, 1994, p. 128).

The evolution of threshing technology attracted much attention in Italy in the 19th century, and the costs and benefits of alternative techniques were discussed at length. Table 1 reports three of the most reliable examples of this literature.[4] These figures must be considered with a lot of caution. The productivity depended on the cereal to be threshed (wheat, barley etc.), on the way in which it was cut (with sickle or scythe, with short or long straw etc.), on the skill and strength of the workers and on the state of the machinery. The wages and the cost of horses varied very much in time and space and the fixed costs of machinery were inversely proportional to the amount of work. The wide differences between the figures in panels (a) and (b), the work of a knowledgeable university professor, show how tricky these computations were. The evidence on actual threshing costs (Table 2) is unfortunately quite scarce and, at least in one case (the Conti, 1887), somewhat suspicious. That source reports the results of a survey among landowners about the returns to wheat growing during the agricultural crisis of the early 1880s. The authors might have exaggerated the costs in order to support their claims for protection.

Tentative as they are, the data highlight two important points.

First, steam-threshing was a capital-intensive-labour saving innovation. In the 1880s in Italy, a fully operational machine cost about 1,500 lit pr HP, and

Table 1. The Cost of Alternative Threshing Technologies: Technical Sources.

Panel (a)

	Productivity (quintals/hour/men)	Cost (lit./q.le).
Hand with flail	0.08	2.18
Horse treading	0.11	1.75
Men-powered threshers	0.12	1.37
Horse-powered threshers	0.11	1.10
Steam thresher	0.47	1.53

Panel (b)

	Productivity	Cost
Hand with flail		1.67
Horse treading		2.01
Men-powered threshers*	0.16–0.28	O.65–1.21
Horse-powered threshers *	0.23–0.31	0.44–0.58
Steam thresher		1.33

Panel (c)

,	Productivity		Cost	
Handthreshing "al banco"	0.05	0.07	1.5	1.9
Hand threshing with flail	0.07	0.08	1.35	
Horse treading	0.08		1.15	1.3
Horse with rolls	0.10		0.95	1.10
Men-powered threshers	0.15	0.20	1	1.35
Horse-powered threshers	0.19	0.25	0.8	1.15
Steam thresher #	0.33	0.55	1.0	1.1

* different types; # 6–8 HP.
Sources: (a) Caruso, 1873; (b) Caruso, 1875; (c) Niccoli-Fanti, 1924 pp. 321–326.

10,000 overall (as much as 5,000–6,000 days of pay of a day labourer), ten times as much as a horse-powered thresher.[5] The productivity of labour was correspondingly higher. Clark (1989, Table 2) reports a wide range of data on labour productivity for threshing with flail – ranging from 0.04 quintals/hour in Moravia in 1838 to 0.23 in the North United States in 1820–1850, with an average of 0.11 quintals. The labour productivity of man and horse-powered machinery was about 0.2–0.3 quintals per hour/worker.[6] Second, steam threshing was indeed cheaper than the traditional methods, but apparently no more so

Table 2. The Cost of Altemative Threshing Technologies: Other Sources.

	Year	Cases	Cost	Source
"Traditional"				
Flail	Early 1880s	3	2.25	Conti, 1887
Horses	1882–1887	1	1.37	Galassi, 1986, n.37°
	Early 1880s	11	2.29	Conti, 1887
Not specified	Late 1870s	4	1.34	Inchiesta Jacini*
Steam				
	1882–1887	1	0.80	Galassi, 1986, n. 37
	1872–1893	1	1.15	Galassi, 1993, Tables 1 and 2
	Late-1870s	4	1.15	inchiesta Jacini
	Early-1880s	12	1.44	Conti, 1887
	Mid-1880s	12	1.17	Risultati, 1885–1888

* treading or with rolls ° actual data from a Tuscan farm.

than other types of mechanised processing.[7] Actually, the horse-powered machinery might have been the cheapest system at least until the 1870s.

3. STEAM-THRESHING IN ITALY IN THE LATE 1880s

The early diffusion of steam-threshing in Italy is exceptionally well documented. In the mid-1880s the government decided that steam boilers were a health hazard which had to be monitored closely. As a first step, in October 1886 the Ministero di Agricoltura, Industria e Commercio began a detailed census of the existing boilers. The operation lasted four years, but the results were highly rewarding, at least from the historian's point of view.[8] The Statistica 1890 has a separate entry for each of boiler, which reports the location, type, material, power, steam pressure, fuel, date of installation, provenance and sector of utilisation. This paper singles out all the boilers labelled as in use for threshing (either full or part-time), and in "agriculture" without further detail, provided they worked for less than 60 days per year, and were portable ("locomobili"). Some of these latter might not have been used for threshing, but whatever overestimation of the data was compensated by the omission of other boilers.[9] If any, the source understates the total stock.

The Statistica lists 3074 boilers for threshing (including the part-time and the "likely" ones), with a combined power of about 21,000 HP. They accounted for about a third of all Italian boilers (9,984) and for 13% of total

power (157,390 HP), but, as shown by the data of Table 3, differed from the rest of the stock.

Most of these differences can be easily explained. Firewood was surely cheaper than coal in the countryside, even if it is difficult to estimate the extent of savings. The machines had to be portable because it was cheaper to move a thresher then the cereals. Most of the fixed machines were used for rice (Loria, 1961). And the smaller the machines, the easier it was moving them around. Finally, more foreign-built boilers were used for threshing than for other activities.[10] Bardini (1997) has shown that Italy imported boilers that were usually more technically advanced than Italian ones. Boilers for threshing need not be really sophisticated. The really complex machine was the thresher itself, and apparently, the Italian firms were not really good at building them. Only in Veneto, domestic firms succeeded in gaining a substantial market share – up to a half of all boilers for threshing (Lazzarini, 1992; Bigatti, 1988). Thus, the region accounted for about half of all the Italian-produced boilers. The reasons of this (relatively) brilliant performance are unclear, as the region was not specially known for its engineering industry. The competitiveness of domestic

Table 3. Boilers for Threshing and All Other Boilers.

	Threshing			Others°		
	n.	HP	%*	n.	HP	%*
Fuel						
Coal	434	3074	14.7	5281	115675	84.8
Wood	1822	11976	57.3	422	4754	3.5
Coal + wood	807	5773	27.6	610	6979	5.1
Other (incl. gas)	11	80	0.4	597	9081	6.7
Average power		6.8			19.3	
Mobility						
Portable	304	20601	98.6	609	5103	3.7
Fixed	34	302	1.4	6301	131385	96.3
Provenance						
Domestic	868	5624	26.9	4244	76313	55.9
Unknown	12	936	4.5	174	1890	1.4
Import	2086	14343	68.6	2492	58285	42.7

* on HP

° including agricultural uses other than threshing.

Source: Statistica, 1890.

producers was to improve later, but much less than in other industries: as late as 1935, after half a century of industrial growth and some years of high protection to engineering industry, foreign threshers still accounted for at least half the total stock.[11]

The diffusion of steam-threshing did entail a massive investment of capital. In the late 1880s, steam-threshers accounted for about a fifth of total capital in machines and tools of Italian agriculture.[12] Actually, and quite surprisingly, cereal-growing was quite a steam-intensive activity: the share of threshing on total stock of boilers did exceed by far that of cereal growing on Italian Value Added, some 8% in 1911 (Federico & O'Rourke, 2000).

Last but not least, the development of steam threshing was heavily concentrated in a relatively small area. Three quarters of boilers for threshing were located in the North, a fifth in the Centre (including Latium) and a meagre 6% in the South. There were no boilers to that purpose in 18 provinces out of 69 (a province is roughly the size of an American county) and more than 80% of the total power clustered in twenty provinces alone (Table 7, Col. a) – all but five in the Po Valley. Viceversa, many Northern provinces (including the whole Liguria) had no steam-threshers at all, and the threshing power in the whole Piedmont barely exceeded half of that of the province of Bologna. Indeed, also wheat growing was unevenly distributed among provinces, but the differences in the output to be processed were much smaller.

4. THE DIFFUSION OF STEAM-THRESHING IN ITALY

Steam-threshing was imported quite early in Italy. The oldest registered machine in the *Statistica* dates back to 1843, only two years after the first commercial sale in the United Kingdom. However, after this promising start, the new technique spread only very slowly. The source registers only 120 machines installed before 1865 – admittedly a lower bound as some of the early threshers may have been scrapped in the meanwhile. Anyway, the number of new machines remained rather low until the late 1860s. The number began to grow in the early 1870s, and soared towards the end of the decade. Almost half of the total stock registered by the Statistica was installed from 1877 to 1882. Then the boom petered out, and in 1883–1885 the number of new machines shrank to the early 1870s level.

The late 1880s were only the dawn of the era of the steam-thresher. The number and power of these machines went on growing quite fast until the 1920s (Table 4).

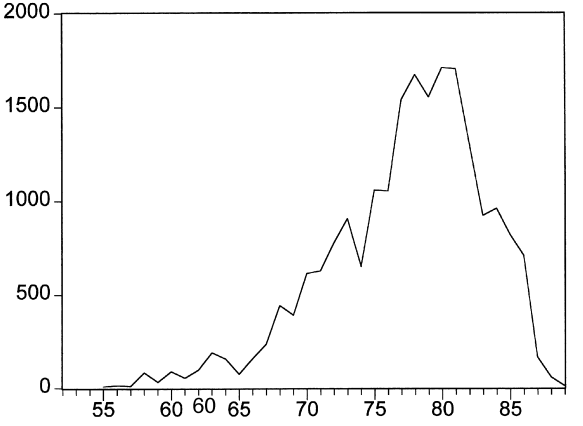

Fig. 1. New Installation Per Year (HP).

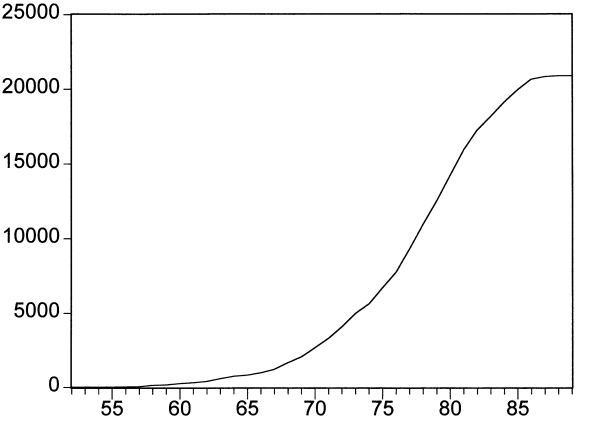

Fig. 2. Stock of Threshers (HP).

The growth in average power reflects the increasing use of more powerful and sophisticated "complete" machines, even if the leap between 1899 and 1904 is partly spurious.[13] Part of the increase after 1904 may have been caused by the substitution of steam by the internal combustion engine. In 1935 the internal combustion engines accounted for about three fifths of the total, steam for a

Table 4. Number and Power of Steam Threshers.*

	Threshers		Growth rates		HP/	% total
	Number	HP	Number	HP	Thresher	agriculture
1865	117	830			7.1	57.4
1875	907	6,705	20.4	20.9	7.4	59.3
1880	2,002	14,233	15.8	15.1	7.1	61.1
1887	3,074	20,903	6.1	5.5	6.8	65.0
1894	5,620	43,987	8.6	10.6	7.8	61.7
1899	6,050	43,950	1.2	–	7.3	48.5
1904	10,302	123,701	8.9	20.7	12.0	77.1
1928	21,499		3.1			
1935	26,176	403,385	2.8	3.8	15.4	n.a.
1947	29,745		1.1			

* current boundaries.

Sources: 1865–1887 Statistica, 1890[30]; 1894 and 1899 Statistica, 1899; 1904 Statistica, 1904; 1928 ASI, 1929; 1935 Indagine, 1935; 1947 Costo, 1949.

mere quarter (probably almost all installed before 1915), and the rest was powered by gas or electricity (Indagine, 1935, prosp. 5).

The number of boilers or their power is not really a revealing piece of information for the uninitiated. The key parameter is the proportion of total crop they could process. The figure can be computed (for any given year or province) as:

$$\% = (HP^* \alpha^* \beta^* \gamma)/P$$

where HP is the total number of HP, α the average number of working days, β the average length of the work day, γ the "productivity" (quantity of cereals threshed) per HP/hour and P the total output to be processed. The details of estimation of these parameters are reported in Appendix A, and the results are reported in Table 5. It is then possible to trace the increase of the percentage of cereals threshed by steam (Table 6). Until the mid-1880s, the percentage shadowed quite well the growth in equipment – up to a fifth of the crop. Afterwards, the share of threshed output did not grow as much as the total power. A (nearly) four-fold increase in total power from 1904 to 1935 brought about only few additional points in the share. In those years, the output (the denominator) increased by almost half, while the productivity per HP/day and the number of days fell by 15% and 35% respectively. The decline in the

Table 5. Productivity of Steam Threshers.

			γ (quintals/HP/hour)			Total (quintals/year)		
	α	β	Min	Best	Max	Min	Best	Max
1887	42	10	1.0	1.20	1.50	2900	3500	4300
1894	40	10	0.95	1.14	1.42	2950	3550	4400
1899	37	10	0.98	1.17	1.46	2600	3150	3900
1904	34	10	0.73	0.88	1.10	3000	3600	4500
1935	22	10		0.70		2450	2450	2450

Source: Appendix A.

Table 6. Percentages of Steam Threshing: Change in Time.

	Lower	Best	Upper
1866–1868	1.2	1.4	1.8
1869–1871	2.4	2.9	3.7
1872–1874	4.5	5.4	6.8
1875–1878	8.4	10.0	12.6
1879–1881	12.9	15.5	19.3
1882–1884	15.2	18.2	22.8
1885–1888	19.6	22.9	28.6
1894	30.3	36.3	45.4
1899	29.4	35.3	44.1
1904	52.3	62.8	74.4
1935		69.7	

Source: 1866–1868/1904 Appendix A, 1935 Indagine, 1935.[31]

number of days can be tentatively attributed to the growing competition among threshers (Vitali, 1939; Potenza, 1947). The "productivity" was falling as capital was substituting labour, and more and more operations were mechanised. The modern machines of the 1930s used only half their total power for threshing proper (Carena, 1942 p. 49). It can be computed that, had these two coefficients remained constant at their 1880s level, the total threshing capacity would have exceeded the output by a third. Actually it would have exceeded the production even if the number of days only had remained constant and productivity had fallen.

A look at the share by province in the 1880s (Table 7 col. b) confirms the geographical concentration of steam threshing. In 10 provinces it processed almost the whole crop, but already at the twentieth place in the rank the share was down to a third.[14] The list (Table 7, col. b) coincides almost perfectly with that of the twenty provinces with the highest threshing power – but the ranking is quite different.

In the following decades, steam-threshing spread outside the "core" areas of the Po Valley, but the lack of data before the 1930s prevents to outline the process with any precision. In 1935 mechanised threshing was almost universal in the North and Centre, while in the South about 80% of cereals were still threshed by traditional methods (down from almost 99% fifty years before). These latter still were in use as late as 1949, albeit for "modest" quantities (Costo, 1949 p. 23).

The discussion so far has focused on steam threshing: what about the other "modern" technologies, the man and horse-powered machines? They were surely

Table 7. Share of Steam Threshing, by Province.

(a)		(b)	
Bologna	6.3	Venezia	136.4
Vicenza	6.1	Ferrara	121.6
Ferrara	5.9	Vicenza	114.4
Padova	5.7	Verona	106.6
Roma	5.5	Modena	99.2
Rovino	5.4	Reggio Emilia	92.9
Verona	5.3	Rovigo	87.5
Mantova	5.0	Grosseto	83.8
Modena	3.8	Mantova	82.5
Milano	3.7	Milano	78.4
Grosseto	3.7	Piacenza	65.7
Venezia	3.7	Cremona	60.8
Reggio Emilia	3.4	Brescia	58.0
Cremona	3.3	Bologna	56.6
Parrna	2.5	Padova	55.1
Perugia	2.5	Treviso	50.6
Siena	2.4	Parma	46.8
Foggia	2.4	Siena	44.8
Ravenna	2.4	Roma	41.6
Piacenza	2.2	Ravenna	37.5

(a) share of each province on the total threshing power; (b) proportion of steam-threshed cereals (computed with the "best guess" productivity estimate of Table 4) out of total output.
Source: see text.

known, but the evidence on their use is mixed, to say the least. The only data are provided by survey of sales of agricultural machinery by a sample of 27 engineering firms in 1875–1879 (Notizie, 1878–1879, Vol 3, p. 88). In these four years, they sold 1,856 thresher (of any kind), while the Statistica registers only 897 new boilers for threshing: at least 959 must have been man and horse-powered machines (and the number was probably higher, as the sample did not include all the firms selling steam threshers). Official sources, such as the Inchiesta Jacini or other enquiries do quote the use of man-powered machines and, much less frequently, of horse-powered ones.[15] Unfortunately, these quotations are quite scattered and apparently casual, and a missing reference is somewhat hard to interpret. But the small number of references to horse-powered threshers seems to rule out a widespread use of them. The case may have been different for men-powered threshers. The 1935 survey (Indagine, 1935) listed still 1878 active machines, three quarters of which in Liguria, Trentino and Venezia-Giulia (these two last regions still belonging to the Austrian Empire in the 1880s). These were hilly areas of small family farms, which appeared to be particularly suited to the small men-powered machines. There were many similar areas all around the country – including most of Piedmont and Northern Lombardy, where in the 1930s mechanised threshing prevailed. Had these areas adopted men-powered threshing – say – in the 1850s–1860s, and switched later to steam-threshing or simply jumped from the flail to the modern machines? It is impossible to tell.

How did Italy fare in comparison with other countries? Was it so backward as assumed by the conventional wisdom? Answering to these questions is far from easy. The diffusion of steam-threshers has not attracted the attention of foreign statistical offices as much as of the Italian one. There are few data, and some of them are hardly useful. For instance the often-quoted figures by Dowring (1965, Table 58) do not distinguish steam from horse or man-powered threshers. If they referred to steam threshers alone, the productive capacity would have exceeded by far the total output to be processed. Nor really useful are the Van Zanden's data on the number of farms employing threshing machines (of any sort) in the early 1900s, without data on the distribution of cereal output by size of farm.[16] There is however some scattered evidence, which suggests that the pattern of diffusion of steam threshers depended to a remarkable extent on the previous trends.

In the advanced countries, steam-threshing replaced horse-powered threshing, which had spread in the first half of the 19th century. In the United States (Bidwell-Falconer, 1925; Rogin, 1931; Wik, 1953; Danhof, 1962; MacClelland, 1997), the United Kingdom (Collins, 1972; Fox, 1978; Macdonald, 1978) and Australia (Raby, 1996) the process started in earnest in the 1850s and 1860s.

In the United States, steam dominated in the core wheat-growing areas already by the early 1880s, even if the traditional techniques and horse-powered machines survived in the fringes, such as the New England until the end of the 19th century. In North-Western Europe, steam-threshing was much less successful. In France, it began to spread in the late 1840s, early 1850s.[17] An agricultural survey in 1852 registered some 400–500 steam-threshers and about 60,000 horse-powered ones, while thirty years later, the numbers had risen to 9,000 (with 42,000 HP) and 200,000 respectively. The share of steam on total threshing power may not have exceeded a 20% – i.e. the same level of the Italian one.[18] In Germany, in 1907, steam was used only by a third of the farms which used mechanised threshing, i.e. by about 10% of the total (Van Zanden, 1991, p. 233). In Belgium, steam-threshers accounted for 15% of total threshing power in 1910 and a 25% in 1929 (Blomme, 1993, p. 184), and in the Netherlands for a mere 4% in 1905 (Van Zanden, 1991, p. 233). Also in Canada and Argentina the horse-powered machinery remained the standard until quite late in time, and it enjoyed a sort of revival in Canada on the eve of World War I (Adelman, 1994, pp. 227–228, 244–245).

"Peripheral" European countries, such as Italy, seem to have jumped from traditional methods directly to steam threshing. The timing of the process differed quite markedly. In the wheat-growing plains of Russia, Hungary and Southern Turkey, around Adana) steam-threshing developed impressively.[19] On the contrary, the Mediterranean countries (other than Italy) lagged behind. In the 1880s, the whole of Spain, there were only 52 steam-threshers (Simpson, 1996), in Portugal less than 10 (Reis, 1992, Table 15).

Summing up the (admittedly scarce) evidence available suggests that Italy was not as backward, at least from this point of view, as argued by the conventional wisdom. It could not compete with the USA or the United Kingdom, but was roughly at a par or even preceded other "advanced" Northern European countries. This was surely not the case for other machines, and this peculiarity has to be understood.

5. THE DIFFUSION OF STEAM-THRESHING: AN ECONOMETRIC ANALYSIS

The selection of a technique (steam threshing in the case at hand) depended on the unit costs relative to the alternative ones. The key parameters were thus the productivity and the expected prices of relevant inputs – i.e. labour, capital and fuel for steam threshing, labour and the price of horses for the alternative techniques. It is likely that the would-be investors formed their expectations

averaging out several years of the relevant variables, albeit the length of the period cannot be ascertained a priori. They could be take into account other variables as well. For instance, they might want to consider the conditions of the labour market. It was easier to gather the large teams necessary for steam-threshing where there were many day-labourers for hire than in areas of household farming, where each household may have had its own ideas on how to allocate its time. On the other hand, the appeal of a labour-saving innovation such as steam-threshing was the larger the more militant the day-labourers were. Another potentially important variable was the probability of rainfall, as there were no barns to store the wheat before threshing. *Ceteris paribus*, steam-threshing was quicker than any other method.[20]

Last but surely not least, the decision was influenced by the expectation about the amount of product to be processed. The steam-thresher was more profitable than the competing techniques only if its output exceeded a minimum, some 450–500 quintals if the alternative was the flail and 1200–1500 quintals if it was the horse-powered machine (cf. Appendix B). This fact affected the diffusion of steam-threshers in three different ways. First, as argued by David (1971) in a well-known article about reapers, the innovation might not be adopted simply because the farm was too small to produce enough cereals. The minimum amounts of wheat quoted above were produced on average (nation-wide) in 50–60 and 135–170 hectares respectively, but the size of the farm had to be substantially greater. Second, either one had to gather the cereals in one location, or to move around the thresher: in both cases, the task was easier if the terrain was level and the rural roads were good. The conditions in late 19th century Italy were so bad as to prompt the government to set up two prize competitions among builders specifically aimed at small machines (Concorso, 1880; Concorso, 1885).[21] Third the decision whether to adopt steam-threshing or not depended on the likelihood that in future the production stayed above the threshold, and the assessment of that probability was likely to depend on past trends in prices.

Summing up, the adoption of steam-threshing was positively related to the productivity growth, wages, the cost of horse power, the productivity of threshers, the share of farms exceeding a minimum size, the amount of rainfall, the percentage of day labourers on the totall agricultural workforce, their degree of militancy, the production and prices of cereals, the conditions of rural roads and the share of plains on total acreage. It was negatively related to the cost of capital, the cost of threshers and the cost of fuel. Most of these variables could explain both the changes in time and the differences among provinces. There are however some exceptions. The amount of rainfall did not change through time, while all price variables could account for differences in the

spatial distribution of threshing only if the relevant markets were not integrated. Furthermore, the available data seriously constraint the analysis (cf. Appendix D for details). There are simply no data on variables such as the conditions of rural roads, the degree of militancy and the cost of threshers – and thus they have to be dropped.[22] Many other variables have to be proxied. Following a common practice, productivity growth is proxied by a time trend. The wages in the time-series regression are proxied by a series for urban unskilled wages – assuming that the labour market worked efficiently enough. The unavailable data on wages and the cost of horses by province in those years are substituted by the number of male labourers and of (rural) horses per hectare.

The dependent variable in the cross section is the number of HP per wheat acre by province. The dependent variable is truncated and thus the equations are estimated both with a standard OLS regression (with a White correction for heteroskedasticity) and with a Tobit regression model. Many variables are not significant, so Table 8 presents the results of the estimation also of a reduced model, with only the significant ones.[23]

The Tobit and OLS regressions yield very similar results, and a Wald test fails to find any significant difference among the estimated coefficients. The statistical results are good, even if the poor results of the RESET test points out to the omission of some potentially important variables. Four variables only, the interest rate, the labour endowment, the dummy and the share of plains are significant. The latter variable might capture also the effect of a greater diffusion of wheat-growing in plains.

The coefficients of Table 8 are difficult to interpret. A simple method to assess the importance of each variable is to estimate how large (small) the total threshing power would have been if that variable had been in the whole country at either extreme of the actual range of values by province (Table 9).

The first row shows how sensitive the stock of threshers was to the interest rates. A relatively small variation in these latter would have changed the (counterfactual) stock of threshers very much. It capital had cost throughout the whole country as little as in Cremona the threshing power would have been (almost) three times as large; if, on the contrary, interest rates had been as high as in Bari, there would have been no steam thresher at all in Italy. The effect of the labour/land ratio and of the share of plains is somewhat smaller, especially if compared with the wider range of the explicative variables, but still quite substantial.

The time series regression (Table 10) is estimated in log-linear form. The dependent variable is the number of new HP installed each year from 1863 to 1885. Some of the explicative variables are not available for the years before 1861, and anyway the data for the 1850s are likely to be biased, as some of

Table 8. Econometric Analysis: Cross Section by Province.

	Full model		Reduced	
	OLS	Tobit	OLS	Tobit
Constant	0.412	0.541	0.415	0.591
	(4.84)***	(5.15)***	(5.41)	(6.14)***
% Farms > 100 ha.	–0.055	–0.079		
	(0.98)	(1.50)		
Interest rate	–0.054	–0.069	–0.052	–0.075
	(4.80)***	(4.86)***	(5.13)***	(5.93)***
Labour/land ratio	–0.083	–0.178	–0.091	–0.166
	(3.16)***	(3.82)***	(3.25)***	(3.99)***
% plains	0.061	0.054	0.088	0.089
	(1.64)*	(1.88)**	(4.54)***	(4.06)***
Total rainfall	0.00	0.00		
	(0.11)	(0.45)		
% Labourers	0.00	0.00		
	(1.16)	(0.92)		
Horses per ha	0.28	0.54		
	(0.93)	(1.57)		
Dummy Cagliari	–0.19	–0.23	–0.195	–0.247
	(4.76)***	(3.63)***	(3.77)***	(4.21)***
Adj-R^2	0.535	0.577	0.542	0.587
RESET (2)	8.00		5.48	
	(0.00)		(0.006)	
F	10.79		21.15	
	(0.00)		(0.00)	
Log likelihood°		66.30		62.50
		(0.00)		(0.00)

Between parenthesis *t* statistics in OLS regression and *z*-statistics in Tobit model (significant at * 10%, ** 5% *** 1 %).

° Null hypothesis that all variables were zero.

the boilers installed in those years could have been scrapped in the meanwhile. The explicative variables are three-year backward-moving averages: this specification yields the best results in a repeated test with different lag lengths. As for cross section, Table 10 reports the full model (panel a) and a restricted one with the significant variables – both in levels (panel b) and in first differences (panel c).[24]

The results of the first-difference equation (panel c) are rather disappointing: its R^2 is quite low, and only the interest rate is significant. Clearly such a simple

Table 9. Counterfactual Estimates of the Total Threshing Power.

	Actual data		Maximum stock		Minimum stock	
	Variable*	HP	Variable	HP	Variable	HP
Interest	6.8	20,900	5.8a	57,200	8.1b	0°
Lab/land	0.4	20,900	0.1c	35,900	1.3d	0°
% plains	27	20,900	100	59,950	0	10,600

Coefficients from the reduced OLS estimate (Table 8).
* unweighted average for the 69 provinces; ° negative number.
(a) Cremona; (b) Bari; (c) Leghorn (d) Massa-Carrara.

Table 10. Econometric Analysis: Time Series.

	(a)	(b)	(c)
Constant	–5.352	–8.43	–0.122
	(0.30)	(1.29)	(1.15)
Time	0.064	0.062	
	(3.78) ***	(3.92)***	
Interest rate	–3.628	–3.602	–6.207
	(2.34)**	(3.00)***	(2.48)**
Wheat prices	5.711	4.288	–0.837
	(1.77)*	(4.07)***	(0.26)
Fuel prices	0.894		
	(0.72)		
Real wages	1.488		
	(0.50)		
Output cereals	–0.957		
	(0.59)		
Adj-R^2	0.92	0.92	0.15
RESET (2)	1.06	1 25	1.26
	(0.373)	(0.31)	(0.30)
F	40.97	90.91	3.22
	(0.00)	(0.00)	(0.06)
DW	2.12	2.02	1.62
LM(2)	0.13	0.21	11.27
	(0.88)	(0.81)	(0.00)
UROOT°	–3.62	3.30	
	(3.01°)	(3.01°)	

(a) full model; (b) reduced model, level specification; (c) reduced model, first differences. Between parenthesis *t* statistics (significant at * 10%, ** 5% *** 1%) ° critical value of the MacKinnon test for stationarity of the residuals at 5%.

model cannot capture the short-term adjustment process. On the contrary, the level specification yields good statistical results. Neither wages nor the fuel price is significant, possibly because the available series refer to prices in the cities throughout the whole year, and thus are not really representative of the costs in the countryside during the threshing period. The elasticities to wheat prices and to interest rates are quite high. A decrease of one point in the interest rate (which amounted to a fall by 20% at the sample mean) increased the new installation by a 70%. Also technical progress was rather fast: it alone would have caused the total threshing power to grow more than five times from the 1860s to 1885.

A good test of the power of a model is its predictive power. It is possible to estimate the implicit number of HP at any date by simply cumulating a yearly extrapolation of new equipment added net of (an estimate of) the scrapped boilers. Table 11 compares the results of the exercise (based on the coefficients of the reduced model) with the actual stock.

Prima facie, the results are quite poor: the extrapolated stock (col. b) is close to the real one only in 1899, and is about a half in both 1894 and 1904. However, these figures do not take into account the long-run decline in "productivity" (i.e. quantity of cereals threshed) per HP. New functions beyond the simple threshing were being added, and thus more power was necessary to process the same quantity of cereals. This effect can be taken into account by computing a "constant 1885 HP stock" (col. c) as the (estimated) stock in 1894, 1899 and 1904 times the ratio of "productivity" in 1885 to the "productivity" in that year. This estimate is indeed quite close to the actual stock in 1904, but neither in 1894 nor in 1899. The model first underestimates the growth of the stock, and later overestimates it. These differences are arguably accounted for by changes in expectations brought about by changes in trade policy. In 1887, Italy adopted for the first time a duty on wheat, which was repeatedly increased in the following seven years. The increase reassured farmers that the government would not have let prices of wheat fall too much, and this may have stimulated

Table 11. Threshing Power in Italy, 1894–1904 (HP).

	Actual	Predicted		
	(a)	(b)	(c)	(c)/(a)
1894	43,987	28,291	33,265	0.76
1899	43,950	43,907	52,721	1.20
1904	123,701	63,676	115,862	0.94

Source: Col. (a) Table 4; others see text.

the adoption of steam-threshing "ahead of schedule" in the late-1880s early-1890s. The very boom may have slowed down the adoption in the second half of the decade.

6. THE DIFFUSION OF STEAM-THRESHING: AN INTERPRETATION OF THE RESULTS

In spite of some puzzling or disappointing result (partly due to the shortcomings in the available data), the econometric analysis does succeed in explaining the diffusion of steam-threshing in 19th century Italy. The geographical diffusion depended on the endowment of labour and on the environment, while the time profile of innovation was deeply affected by the grain prices. In both cases, the key factor was the availability of capital: steam-threshing spread whenever and wherever the interest rates fell. This conclusion is not exactly startling, nor really new (Galassi, 1993). And it does not tell the whole story. It does not explain why farmers did not buy men or horse-powered machines if they felt the need to modernise threshing, nor why did they not use that "cheap" capital to purchase other type of machinery (reapers etc.).

Why did alternative "modern" techniques not spread? The men-powered thresher had some serious disadvantages in "normal" conditions. Their unit costs were similar to or higher than those of steam-powered machines (Table 2), and their use was extremely tiring. In the word of a textbook, "threshing with these machine cost as much as horse-trampling, with the difference that in this case the men, not the animals, are worked to death" (Niccoli & Fanti, 1924, p. 323; cf. also Cencelli & Lotrionte, 1919, p. 641; Notizie, 1877, p. 857). Threshing by hand might be convenient if the quantity of cereals to be processed was very small and the terrain and the conditions of country roads made the movements of steam-threshers difficult – i.e. in the mountains. As said before, there is some evidence of their diffusion in these cases.

Horse-powered threshers had many advantages, and a serious defect: they needed a lot of horses – at least three per machine (two to pull and a replacement). But in Italy the traditional draught animal was the ox and not the horse (Segre, 1998), and hence the stock of rural horses was quite small. In the mid-1870s there were about 625000 animals in the whole country, cities included (MAIC, 1876) – i.e. about as many as in Ireland, where the arable acreage was ten times smaller.[25] In fact only in Sardinia (the provinces of Cagliari and Sassari), the number of animal exceeded that of farms (Censimento, 1930), and in six other provinces (Grosseto, Cremona, Foggia, Sondrio, Pisa and Ferrara) there was more than one horse every two farms. Even in these areas, horse-powered threshing would have required the pooling of horses of several

farms, and this would have entailed substantial transaction costs, as speed of processing was such a prominent concern. Elsewhere the density was even lower, down to a horse every ten farms or less in 13 provinces.

In theory, the shortage of horses could have been solved in three different ways. The farmers could have used oxen, or could have rented the horses, or a commercial firm could have owned and hired a horse-powered threshing machine and the animals to pull it. None of these solutions was feasible. The threshers had to be adapted to be pulled by oxen (Caruso, 1875, p. 281), and the results were anyway poor. In fact the oxen were too slow and hardly capable to move in narrow circles, and thus they were unsuited to power modern threshers (Notizie, 1878–1879, Vol. III, p. 6). Nor was renting horses feasible, at least in the short run. Each farmer faced a monopoly or oligopoly of the few local horse-owners who could extract as rents the profits of horse-powered machines. Of course, in the long-run, a strong demand of horses for threshing would have stimulated the competition among horse-owners, as there were clearly no barriers to entry. Yet no demand, and hence no competition, materialised: one has to infer that the differential profits from horse-powered threshing were too small to overcome the possible losses from the unemployment of horses during the rest of the year. Finally, there is no evidence whatsoever of horse-powered threshing enterprises in the sources. The risk of unemployment was clearly too great. Threshing lasted at most a month, and the possibility of employing the animals in other activities (e.g. in transportation) during the rest of the year must have been really uncertain.

In a nutshell, horse-powered threshing could have developed only with a radical change in the draught power, which its additional profits alone were too small to foster. The lack of horses hampered the diffusion of horse-powered machine also in Spain (Simpson, 1996, p. 158) and, maybe, in Portugal (Reis, 1992, p. 140). Of course, one could ask why the ox and not the horse had became the standard draught animal in Italy, but this is a different, and more complex, issue (Galassi-Kauffman, 1997; Fenoaltea, 1999, p. 11).

The lack of horses may explain the failed adoption of horse-powered threshing, but not the popularity of steam-powered alternative. Why did Italian landowners invest in a highly capital-intensive piece of equipment instead of sticking to traditional threshing methods and use their scarce capital in some other way?

The simple answer is that they did not, either individually or pooling their resources. Less than a third of steam-threshers was registered as property of landowners, in the 1935 survey (Indagine, 1935, p. 271). There are no comparable data for previous period, but the anecdotal evidence suggests that the share

of threshers owned by landlords was, if any, lower. The majority of Italian machines belonged to threshing firms, which rented them to landowners. The firm provided the machine, and the skilled workforce (the engineer and an assistant), and was paid with a share of the output – usually a 3–4% of the crop.[26] The landowner had to supply the fuel and oil for the machine, the rest of the crew (to feed the machine, carry away the grain and the straw etc.) and the food for all the workers. Yet there is not doubt that he could rely upon traditional methods.

On the other hand, setting up a threshing firm may have been quite a profitable enterprise. The implicit rate of return always exceeded the interest rate on the (best) short-time commercial bills, and the premium, still below 10% in the 1860s, jumped up to 15% in the second half of the 1870s, to fall to about 5% in the 1880s. These figures are computed as a lower bound, under very conservative assumptions – a 3% rent, and the lowest "productivity" coefficient of Table 5. The changes in time of the estimated premium tallies quite well with the timing of the diffusion of steam-threshers: they would perform very well as independent variable in the time-series regression, if one could trust the estimate enough to use it. Of course, these profits had to be balanced with the risk of having the machine left idle for lack of customers. The risk may have been high for the pioneers, as landowners were still not familiar with the new technique. It was bound to fall as steam threshing was spreading.

Fig. 3. Rate of Return to Steam-Threshing: Premium Over Discount Rate.

The prevalence of custom-work can explain the poor results of the firm-size variable in the cross-section (Table 8), and also the much better performance of prices than of output as an explicative variable in the time regression (Table 10b). In fact the profits of the threshing firms were proportional to wheat prices as long as their share on the product remained constant. Of course, in the long run the share was not likely to remain constant, as any substantial extra-profit would attract new competitors in the business. However, in the short run, especially for small price changes, the rate seems to have been fairly sticky, may-be because the transaction costs of changing it were high enough to overcome the benefits of adjustment.

7. CONCLUSIONS

The results so far can be summed up in three points:

- Italy was quite advanced in the adoption of steam-threshing, even if *prima facie* that technology did not suit the country's "environment" and factor endowment.
- the diffusion depended on the cost of capital and on the features of the agriculture in each area. The process started in the Po Valley, where the conditions were more favourable and then spread in the whole country. The boom of the late-1870s early-1880s was made possible by the fall in interest rates and fuelled by sanguine expectations on the prospects of wheat-growing. These predictions proved to be wrong in the short term, but the growth of steam threshing resumed after the imposition of the duty on wheat.
- threshing was usually outsourced to specialised firms, which were quite profitable.

This latter point seems especially interesting in a wider perspective. Custom-work eased the constraint from the size of farms. Italian sources quote it very seldom, if at all, as a obstacle to the diffusion of steam threshing.[27] Indeed, custom work was the rule for threshing in the United States (Wik, 1953; Isern, 1981), England (Collins, 1972), Australia (Raby, 1996) Argentina (Adelman, 1994) and was widespread in Canada as well (Adelman, 1994). On the contrary, custom-work was uncommon in Spain (Simpson, 1996) and in Portugal (Reis, 1992), where farm size is said to have been a major obstacle to the development of steam-threshing. In Spain, steam threshing developed only quite late, in the 1900s, as a co-operative undertaking. Arguably this solution was less efficient than the custom work. In fact the co-operative entailed sizeable transaction costs in the allocation of

threshing time among members, given the advantages of having his own wheat threshed first.

To be sure, the development of an efficient institution to circumvent a technical constraint should not surprise an economist. However, this "achievement" may come to a surprise for most Italian historians, who usually assume that institutions could not adapt to changing circumstances, and attribute to this rigidity the alleged failure of the Italian agriculture.

NOTES

1. Inchiesta Jacini II p. 106; Similar statements on the diffusion of steam threshing from the same source in Lombardy (VI.1, pp. 343, 506; VI.2, pp. 58, 459, 617, 827, 925), Campania (VII, p.117). Piedmont (VIII.1, p. 270; VIII.2, p. 64), Calabria (IX.1, p. 17), Latium (XI.1, p. 321), Marches (XI.2, pp. 430, 886). Cf. also Relazione, 1870–1874, pp. 609, 614 (Veneto), 615 (Emilia), Condizioni 1884 (Rome) and the historical works by Varni, 1988 and Corona Massullo, 1989.

2. An account of agricultural activities by J. Wilkinson (Chaloner, 1957, p. 51) mentions a steam-powered thresher as early as 1798. The machine was however "of a cumbersome and expensive construction", and this may explain the lack of imitators.

3. Some horse-driven combined harvesters were used in California (Olmstead-Rhode 1993) but they were really unwieldy (e.g. they had to be pulled by 50 horses).

4. It is assumed that an hectolitre weighted 0.75 quintals and a "sacca" (a Tuscan unit) 0.55 quintals. Cf. other examples in Carega, 1859, Salvagnoli, 1852 and Rapporto, 1853 and also the data reported by Simpson (1996, pp. 156–158) and Reis (1992, p. 123), which cast some doubts about the advantages of steam threshing over horse trampling.

5. Cf. the extensive evidence on prices in Concorso, 1880 (an average of 1700 lit/HP) and Concorso, 1885 (1400 lit/HP), Carega, 1859; Salvagnoli, 1852; Cuppari, 1870, p. 202; Muzi, 1882, pp. 96–97; Relazione, 1870–1874, Vol. II, p. 52; and Galassi, 1993 (who quotes an actual purchase price). In the late 1890s, the price per HP was down to 1100 lit. (Niccoli, 1898 p.191), but the average power was greater as well, so the unit cost of a machine had not changed so much. The cost of horse-powered threshers is from Cuppari, 1870, p. 202; Niccoli, 1898, p. 191.

6. Cf. for men-powered machines Notizie, 1878–1879, Vol. III, pp. 63–64; Notizie, 1876, p. 276; Notizie, 1877, p. 857; Inchiesta Jacini, VI.1, p. 461; Cencelli and Lotrionte, 1919; and Niccoli and Fanti, 1924; for horse-powered ones Notizie, 1877, p. 857; Coupan, 1913; Herve-Mangon, 1875; Salvagnoli, 1852; Niccoli and Fanti, 1924; Collins, 1972, p. 21; and Rogin, 1931, pp. 182 ff. for the United States. The computation assumes that a horse was equivalent to six man in Italy and to three in the United States (according to the relative cost).

7. In theory, steam threshing had an additional advantage: it eliminated the losses of product, a rather serious problem with traditional methods (Giacomelli, 1864; Herve & Mangon, 1875; Niccoli & Fanti, 1924; Collins, 1972). The reality might have been different: Vitali, 1939 complains that the poor maintenance of the machines and a too hasty work caused high losses.

8. Statistica, 1890. Twelve provinces out of 69 were surveyed in 1886, 34 in 1887, 20 in 1888, one in 1889 and the two last ones in 1890.

9. The "likely" threshers accounted for less than 10% of the total stock (some 500 machines with 4700 HP), but their share was quite substantial in some provinces such as Venice (41%) and Milan (93%). There is evidence of omissions in the Po delta (Lazzarini, 1995, pp. 312–313), in the province of Pavia (Inchiesta Jacini, VI.2, pp. 58 and 154) in Tuscany (Galassi, 1997) and in Sardinia (Notizie, 1878–1879, III, p. 65 and Inchiesta Jacini, XIV, p. 344).

10. The figures may even understate the real share of imported machinery, if, as likely, the number of Italian boilers powering foreign threshers exceeded that of foreign boilers powering Italian machines.

11. Indagine, 1935; out of the 26,176 threshers then existing in the country, 9,214 had been produced in Italy and 13,298 imported (the provenance of the other 3,664 is unknown).

12. The total value of the stock amounted to some 30 millions lire at replacement cost and maybe somewhat less than half that sum at the actual value – assuming a 25-years productive life as suggested by Bardini (1997, Table 7). According to the available series, the net value of "agricultural implements and machinery" in 1889 was about 75 millions at current prices (Ercolani, 1969, Table, XII.3.5).

13. The owner of the boiler provided data on the heating surface, which were converted in power (HP) by the statistical central bureau. In 1894 and 1899 (following a suggestion of Statistica, 1890), it assumed that a square meter of surface produced 0.83 HP in any type of boiler. In 1904, it raised the coefficient to 0.91 for fixed boilers and to 1.33 for the portable boilers (Statistica, 1904). The power per square meter was indeed growing, as the efficiency of boiler was improving (Colombo, 1920, p. 344), but the posited increase seems too abrupt.

14. A figure in excess of 100 is not necessarily an error: the equipment could have been used to thresh the wheat in neighbouring provinces.

15. Men-powered machines were in use in Piedmont (Inchiesta Jacini, VIII.1, p. 270), in the provinces of Vicenza (V.1, p. 362), Bergamo, Brescia and Cremona in Lombardy (VI.2, pp. 617, 712 and 925 respectively), Genova and ("few") Massa in Liguria (X, pp. 456 and 729), in Tuscany (III, p. 170, "few"), in Ascoli Piceno, Macerata ("few") and Pesaro in the Marche (XI.2, pp. 889, 900) and ("a handful") in Sicily (XIII.1.3, p. 325). Cf. also the Relazione, 1870–1874, II, p. 603 (Piedmont) and 609 (Veneto), Notizie, 1877, pp. 857–860 (provinces of Novara, Udine, Avellino and Cagliari), and Notizie 1878–1879, III, p. 60–61 (Chieti). On the contrary, horse powered machines are quoted by the Inchiesta Jacini only three times, in Mantova (VI.2, p. 827), Potenza and Catanzaro in Calabria (IX.1, pp. 17, 148). A textbook (Giacomelli, 1864, p. 306) states that this type of machine was "the most diffused", but without any detail.

16. Mechanised threshing was used by a third of German farms, a quarter of Danish, a fifth of Swiss and a mere tenth of Austrian ones (Van Zanden, 1991 p. 233). Van Zanden reports also some data on the share of farms, which *owned* a thresher in France, the Netherlands, Belgium and Hungary (all ranging between 4% and 6% of the total). They surely underestimate the actual use of threshing machines, which were often shared or rented.

17. Cf. Agulhon, Desert and Specklin, 1976; Laurent, 1976, p. 681; and Demonet, 1985, pp. 79–81. The mechanisation contributed substantially to the increase in labour productivity in wheat cultivation (Grantham, 1991, Tables 13.8–13.9).

18. France produced about 14.5 millions of tons of threshable cereals (Mitchell, 1976, Table D.2), while horse-powered machines could process up to 1500–2000 quintals in a season and steam-powered ones up to 3500–4000 (cf. Table 5). Both figures are computed assuming 40 days of work, which are probably too many.

19. In Russia there were 20,000 threshers in 1911 (Reis, 1992, p. 99) i.e. roughly two times more than in Italy, but the Russian grain output was 10 times the Italian one (cf. also Kahk, 1988 for Estony). In Hungary the first steam-thresher was imported in 1854, and the number rose to some 230 in 1863 (Komlos, 1983, p. 67), to 2,400 in 1872 and to 8,920 in 1895 – plus some 46,800 horse driven machines (Voros, 1980, pp. 68–69). By then, traditional methods were in use only in the mountains. Cf. for the Adana area Quataert, 1981, p. 78.

20. Speed is frequently quoted as one of the advantages of steam threshing (cf. Giacomelli, 1864, p. 301; Carega, 1859, p. 97; Caruso, 1875, p. 281; Inchiesta Jacini, XI.2, p. 909; and also the discussion in Reis, 1992, p. 135). Hobsbwam-Rudè (1969, p. 369) argue that speed was sought after as market prices of wheat fell markedly in the weeks after the harvest. The first farmers to bring their product to the market enjoyed a substantial advantage.

21. In 22 provinces out of 60, there were no plains at all, while only four (Cremona, Ferrara, Rovigo and Venice) were totally level. They accounted for 18% of total Italian threshing power.

22. Reis (1991) provides a series of thresher prices, which however is almost flat, apart from a hike in the early 1870s.

23. The dummy refers to the province of Cagliari (Sardegna). The source reports an unrealistically low figure for the interest rate in that province – about half the national average.

24. All series are I(1), except the real wages, which are a I(2). Both the full and restricted form (Table 10a and b) of the level specification model pass the Johansen cointegration test for the variables at 1% and show no sign of serial correlation (LM test) or of omission of variables (RESET). On the contrary, the first difference specification (Table 10 c) pass none of these tests.

25. Turner, 1996 table 2.4; however in Italy there were five times more mules and asses – 293000 and 674000 respectively, against a cumulated total in Ireland of about 200000.

26. Cf. Relazione, 1870–1874, II, p. 608 (Cremona) and 614 (Padova), Inchiesta Jacini, II, pp. 106 and 187 (Emilia), V.1, p. 97 (Verona), VI.2, p. 154 (Pavia) and 925 (Cremona), VIII.1, p. 270 (Piemonte), XI.2, p. 915 (Pesono), Risultati, 1885–1888, p. 67 (Pavia) and 146 (Udine), Conti, 1887, p. 9 (Alessandria), p. 83 (Parma) p. 125 (Perugia), Niccoli, 1898, p. 191. The percentage was higher in few cases, up to 6% in the surroundings of Alba, in Piedmont (Inchiesta Jacini, VIII.2, p. 252). A source of the 1920s suggests a wider range, from 2.5% to 7% (Pagliani & Vitali, 1929, p. 443), while after World War II the cost (a nation-wide average) amounted to 2.27% of the value of the crop in 1946, 2.51% in 1947 and 3.04% in 1948 (Costo, 1949 prosp.8). A 3–4% share of the product was customary in the United States in the 1870s (Wik, 1953, p. 46).

27. Exceptions are Notizie, 1878–1879, Vol. III, p. 62 (Campania) Inchiesta Jacini, X, p. 729 (Liguria) and XI.2, p. 889, Conti, 1887, pp. 173–174 (Apulia). One could

remark that all these notations refer to regions where steam threshing had not developed.

28. Cf. Niccoli, 1898, p. 191; Caruso, 1875, p. 277; Irianni, 1933, p. 420; Costo, 1949, p. 77. Caruso, 1873 and Conti, 1887, pp. 173–174 suggest a longer workday, of 11 and 12 hours respectively. If they were right, the share of threshed wheat on total output would be undervalued.

29. In 1935 the total productive capacity was about 275000 quintals/hour – (cf. footnote 32). Thus, it needed 194 hours, or 19 days, for threshing 53.4 mil. quintals of wheat (Indagine, 1935, prosp.1). The source does not quote the threshing of other cereals – and thus the figure is augmented by 10% – the ratio of the combined output of barley, oats, rice and rye to the output of wheat (Sommario, 1958).

30. The figures for 1865, 1875 and 1880 are simply the cumulated total of new installations until that date. To compute it, the 217 boilers (1723 HP) without a date are distributed by year assuming the same proportion as the registered ones.

31. The original figure refers to the processing of wheat only, which was then subject to regulation. It is assumed to hold true for all cereals. Any resulting bias could not be substantial because wheat accounted for about 90% of the output to be threshed. A later official source (Costo, 1949, p. 77) argues that the figures are underestimated because of tax elusion.

32. Costo, 1949, p. 77 estimates the hourly productivity of threshers according to the length of their awner – a total of 320000 quintals for 29745 machines. Using the same coefficients, the 26176 machines in 1935 would have had a threshing capacity about 275000 quintals/hour or 0.7 quintals/hour/HP.

ACKNOWLEDGMENTS

The author thanks C. Bardini for having provided the databases, Stefano Fenoaltea, Jaime Reis and the participants to the Third Conference of the European Historical Economics Society (Lisbon, October 28–29th, 1999) for their comments to a first version of the paper. The usual disclaimer applies.

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APPENDIX A

The Estimate of the Share of Steam-Threshing

The estimate of the share of steam-threshed output needs data on the total production to be threshed (P), the number of days (α) and hours of work (β) and the hourly productivity per HP (γ), for the period 1865–1886, and the years 1894, 1899 and 1904.

The data on output to be threshed (P) are obtained from the official statistics, with a suitable upward revision to take into account the undervaluation of the data (Federico, 1982, and 2000). The figures for 1894, 1899 and 1904 are three-year moving averages. The output by province is the average of the official data in 1879–1883 (MAIC, 1891) and 1890–1894 (MAIC, 1894) increased by 10% and 25% respectively.

It is assumed that each days of work lasted ten hours, as reported by most sources.[28] The data on the number of workdays in the 1880s is computed as a simple average of the data by boiler (Statistica, 1890), while the figure for 1935 is estimated from the information from Indagine 1935.[29] The figures for 1894, 1899 and 1899 are obtained as linear interpolation, while the number of work-days is assumed to have remained constant in the 1860s and 1870s. This last assumption may cause the share of threshed cereals in those years to be under-valued if the downward trend had begun earlier.

The really thorny issue is anyway the productivity per HP/hour. Some evidence is available from textbooks, proceedings of competitions for the best machine and the catalogues of producing firms (cf. Table A.1).

The figures for the period up to the 1880s are quite consistent, with few outliers, but they are likely to be an upper bound of the actual productivity. In fact most of them were measured in competitions among threshing machines or were declared by the engineering firms. In both cases, they refer to brand-new, state-of-the-art machinery in ideal working conditions. In the real world, a sizeable part of the stock consisted in worn-out, old machines (the average age according to the Statistica was about 10 years), and some time was lost for repairs, small accidents etc. – thus reducing the actual productivity. It seems thus prudent to assume a lower figure – a best guess of 1.2 quintals/hour HP, within a 1.0–1.5 range, for the standard 7 HP boiler.

Unfortunately the evidence on the levels of "productivity" in the 1890s–1900s is too scarce to put forward an estimate. A linear interpolation (as for the number of days) may yield biased results. In fact, as the right-hand column in Table A.1 shows, the productivity per HP was inversely related to the power of the boiler, and, as said in the text, this latter was rising fast in the early 1900s. It

Table A.1. Productivity of Steam-Threshing (quintals wheat/hour/HP).

	Year	Num.	Productivity		Power (HP)		Coef. Cor.#
			Range	Avg.	Range	Avg.	
(a)	1852			7.42		2	
(b)	1850s			1.5		6	
(c)	1859	2	1.8–2.2	2	4–7	5.5	
(d)	1864	3	0.95–1.7	1.4	4–7.5	8.75	
(e)	1873	11	0.7–2.6	1.25	2.1–11.5	7.2	–0.42
(f)	1870s	2	2.0–2.1	2.05	6–10	8	
(g)	1870s			3.8		26	
(h)	1878			1.5		3	
(i)	1880	6	1.2–1.5	1.4	7–13	10.7	–0.79
(j)	1880	11	0.8–2.85	1.63	2.5–5.6	3.5	–0.28
(k)	1883		1.25	1.25		8	
(l)	1885	15	1.05–2.25	1.85	2–5.5	4.2	–0.10
(m)	1887			1.4		7	
(n)	1888	3	2.33–6	3.66	3–6	4.3	
(o)	1898		1.25–1.66			6–8	
(p)	1901	7	1.19–2.22	1.69	4–11.5	6.5	–0.26
(q)	1907		1.33–2.25			Ns	
(r)	1913	5	0.77–0.85	0.8	12–30	20.1	0.08
(s)	1913	4	0.8–1.6	1.12	5–12	8.2	–0.88
(t)	1926		0.71			Ns	
(u)	1925	7	0.6–1.1	0.8	4.5–34	17.6	–0.83
(v)	1933		0.5			30	
(w)	1935		0.7				

between (average) productivity and (average) power.

Sources: (a) Salvagnoli, 1852; (b) Collins, 1972; (c) Carega, 1859; (d) Giacomelli, 1864, p. 316; (e) Herve-Mangon, 1875, p. 766; (f) Wik, 1953; (g) Rogin, 1931; (h) Notizie, 1878–1879, III, p. 60; (i) Concorso, 1880; (j) Coupan, 1913, pp. 328–335 (the results of a competition in Joinville, sponsored by the Société des Agriculteurs de France); (k) Inchiesta Jacini, VI.1, p. 268; (l) Concorso, 1885; (m) Conti, 1887, p. 173–174; (n) Ringelmann, 1888, II, p. 64; (o) Niccoli, 1898, p. 191; (p) Niccoli and Fanti, 1924, pp. 319 and 325; (q) Bordiga, 1907, p. 376; (r) Cei, 1913, p. 348 (threshers built by "Marshall and sons"); (s) Cei, 1913, p. 351 (threshers built by the "Società Italo-Svizzera"); (t) Pagliani and Vitali, 1929, p. 441 (results of a test in Munich); (u) Pagliani and Vitali, 1929, p. 441 (threshers built by "Breda"); (v) Irianni, 1933, p .419–420; (w) Estimate for the whole country from Indagine, 1935 and Costo, 1949.[32]

is thus likely that in those years the hourly productivity per HP has been falling. This effect can be captured by an elasticity productivity/power, which can be obtained by the estimated the regression:

$$\text{Log Productivity} = a + b_1 \log \text{HP} + c_1 \ldots c_n D$$

from a pool of "representative" sources – i.e. those of Table A.1 which reports data on more than one thresher (i.e. the rows e, i, j, l, p, r and s). The set of dummies D refer to the source, to the time period (the 1880s, the 1900s and the 1920s), and to the nature of the data (firms' catalogues versus all other types). Only this latter variable is significant (cf. Table A.2).

Table A.2. Productivity/Average Power.*

Lproductivity =	0.92 – 0.32 LHP – 0.27 Dummyfirms
	(8.17) (5.31) (2.73)
adj-R^2 = 0.49	F 33.98 (0.00) RESET(2) 2.75 (0.07)

t-statistics between brackets.
* White-heteroskedasticity consistent data.

Thus productivity per HP in 1894, 1899 and 1904 is computed assuming that a 1% increase in average power (Table 5) caused it to decrease by 0.3%.

APPENDIX B.

An Estimate of the "Threshold" Farm Size

The threshold can be computed (David, 1974, p. 221) as:

$$T = [(d + 0.5i)/Ls]^* (C/w),$$

where d is the coefficient of depreciation i the interest rate, w daily wage and Ls and C the differences between each pair of two competing techniques respectively in labour use (man-day per unit of acreage) and in total cost of the equipment. The relevant data are reported in Table B.1.

Steam saved about nine days versus the flail and three versus the horse-powered machine, but a steam machine cost 9000 lire more than a horse-powered one (the cost of the flail was negligible). The threshold varies between 45 and 56 hectares (according to the wages) if steam is compared with the flail, and between 130 and 165 if it is compared with the horse-powered machine. These figures are substantially lower those quoted by the literature, some 200–220 hectares in Italy (Niccoli & Fanti, 1924, p. 326) and more than 300 Portugal (Reis, 1992, p. 124). The difference between Italy and Portugal can be accounted for, at least in part, by lower wages.

Table B.1. Data for the Estimatuion of the Threshold.

	Flail	Horse-powered	Steam
Labour use (quintals/man/day)	0.8	0.17	0.40
Yield per ha	9	9	9
Days/ha	11.25	5.3	2.25
Cost (C)	0	1000	10000
Interest (i)	0.055	0.055	0.055
Depreciation (d)	0.033	0.033	0.033
Wages	1.2–1.5	1.2–1.5	1.2–1.5

Sources labour use Table 1; yield from MAIC 1894 increased by 20%; wages Niccoli, 1898.

APPENDIX C

The Estimate of Rate of Return in Commercial Steam-Threshing

The revenues of the threshing firm are computed as 3% of the value of the crop, assuming that each machine processed 2800–3000 quintals of cereals per season (cf. Table 5), and multiplying the quantity by the market price of soft wheat from Sommario (1958). The operating costs included a flat 0.5 lit/day for maintenance and repair (Niccoli, 1898, p. 191) and the wages for the engineer and his assistant. These latter were 6 and 4 lit/day respectively in the 1880s (Conti, 1887; Risultati, 1885–1888), and are retropolated to the 1860s with the unskilled labour wage index of Fenoaltea (1985). The depreciation is computed assuming the simplest straight line model, with an average life of 30 years and a cost of 1500 lit/HP (corresponding to 60 lit/season/HP). The interest rate is the official discount rate (De Mattia, 1967). As such, it may understate the cost of capital to a would-be threshing entrepreneur was probably somewhat higher, especially if he borrowed from the machine-builder and had no land to mortgage.

APPENDIX D.

Sources of Variables for the Econometric Analysis

This Appendix details the sources of the variables employed in the estimation of regressions of Tables 8 and 10, and sketches out the outcome of using alternative sets of data.

Dependent variables

(a) cross-section: number of HP (Statistica, 1890) per hectare of cereal land. This latter is computed by summing the acreage in wheat, barley, rye and oats – as the average of the data for 1879–1883 (MAIC, 1891, Table 1) and 1890–1894 (MAIC, 1894). This variable has been preferred to the (theoretically more appropriate) share on output by province, which takes into account the differences among provinces in yields and in the number of workdays, because the computation of this latter (cf. Table 6) is too much fraught with questionable assumptions to be reliable. Anyway, the coefficient of correlation of the two variables is as high as 0.94.

(b) time series: the new HP installed each year (Statistica, 1890). Using the number of threshers instead of the power yields slightly worse results, while the cumulated stock performs very poorly. (no variable is significant).

Explicative variables

(a) Cross-section

- size of farms. The percentage of farms beyond several different thresholds is taken from the census of agriculture of 1930 (Censimento, 1930), taking into account the changes in the provincial boundaries. The regression in Table 8 adopts 100 ha. as a threshold, but the use of different sizes (e.g. 50 or 500 ha.) does not improve the results.
- the cost of capital is proxied by the discount rate on loans by local saving banks in 1890, the earliest available date (Cotula & Raganelli, 1996).
- the labour/land ratio is computed as the number of gainfully employed males in agriculture (Censimento, 1881) divided the total agricultural land (arable land, permanent meadows and specialised fruit-tree acreage) from the Catasto 1929. The use of these figures implies a small bias, as they include the land reclaimed from the 1880s to the 1920s. Unfortunately, there is no alternative: the available wage series by province (Arcari, 1936) start in 1905, when the great emigration wave had already begun to raise wages in the South.

- share of plains: the percentage of plain on total acreage by province according to the Catasto 1929 adjusted for boundary changes.
- amount of rainfall computed: the cumulated sum of rainfall in July and August as the averages of data from 211 observatories for the period 1938–1957 (ASM 1959 Appendice II). Other specifications (such as the number of days of rain in the same period, or the total rainfall and the number of days in each month separately) yield poor results as well.
- share of labourers on total agricultural workforce from Censimento 1881.
- stock of horses per hectare of acreage. The number of rural horses is obtained as a residual, deducting from the total stock in 1876 (MAIC, 1876) an estimate of urban animals. This latter is computed as the population of cities above 10000 inhabitants according to the 1881 Census (Censimento, 1881) times the average number of horses per inhabitant in a sample of 150 cities in 1908 (Giusti, 1911). The total acreage is taken from the Catasto 1929.

(b) Time series

- the cost of capital is proxied by the discount rate on "cambiali" (short-term bills) computed as the average monthly rates of the Banca d'Italia (De Mattia, 1967 tav.20).
- the price of (soft) wheat is taken from the Sommario 1958, and is deflated with the wholesale price index.
- the cost of labour is proxied by the index of (urban) unskilled construction workers by Fenoaltea (1985) deflated by the consumer price index from Sommario 1958.
- price of fuel is the price of firewood (Sommario, 1958). Tests with the prices of coal at import (Sommario) or in the harbour of Genua (Felloni, 1957) yield similarly poor results.
- the output of cereals is taken from an estimate by the author (details available on request).

WEATHER EFFECTS ON EUROPEAN AGRICULTURAL PRICE INFLATION 1870–1913

Solomos Solomou and Weike Wu

ABSTRACT

This paper considers the non-linear agro-weather price relationship for Britain and Germany during the period 1870–1913. A comparison of Britain and Germany during this period is particularly interesting because of differences in economic structure and trade policy. The share of agriculture in the German economy was significantly larger than in Britain and agricultural protection in Germany contrasts with Britain's unilateral free trade stance. In these circumstances national specific weather shocks are found to have larger sectoral and macroeconomic effects on the German economy.

INTRODUCTION

The relationship between weather and agricultural prices has been extensively studied for the early modern and pre-1850 period (Ashton, 1959; Matthews, 1954; Mathias, 1969; Jones, 1964; Post, 1974; Wrigley, 1989). In contrast, the period of the late 19th Century has been systematically neglected. This neglect does not seem to be justified on the grounds that the agricultural sector was no longer influenced by weather or that agricultural prices were being determined

Advances in Agricultural Economic History, Volume 2, pages 115–143.

ISBN: 0-7623-1001-4

only by international markets and not by nation-specific factors, such as domestic weather conditions. Studies of the agro-weather production relationship suggest that there are significant weather effects on agricultural output. In the case of Britain, France and Germany weather shocks account for one third to two thirds of the growth variations of agricultural output during the period 1870–1913 (Solomou & Wu, 1999; Khatri, Solomou & Wu, 1998). Such production effects are likely to feed through to price effects.

These feedback effects are particularly interesting in a comparative setting because of differences in national trade policy. Tariffs create a wedge between the prices of domestic and international agricultural products. Although this is expected to be observed as a price level effect, if the tariff level was high enough this may amount to a prohibitive tariff allowing country-specific weather shocks to have an effect on domestic inflation even in the era of globalization in the late 19th Century. Under free trade, as exemplified by Britain during this period, we expect production effects not to be fully reflected in price movements since imports can take place at international market prices. Nevertheless, even in these circumstances we are likely to observe imperfect substitution between domestic and international goods, such that there will be some price effect arising. Quantifying the magnitude of this effect will be important to understanding the determinants of agricultural prices and domestic inflation. In this paper we compare Britain (a non-tariff country) and Germany (a protected economy) to evaluate the nature of these agro-weather price linkages.

Addressing the nature of the agro-weather relationship offers us an opportunity to study the effects of shocks on the economic system. Neal (2000) has made the important point that economics, like geology, is an historical subject. In considering the coupling of a natural system such as weather shocks with an economic system, such as the fluctuation of output and inflation rates in a weather sensitive sector, we will be better informed on our understanding of inflation within a specific historical period. In addition, the magnitude and nature of weather shocks varied over time allowing us to model how particular shocks affected the economic system. Given the structure of late 19th Century economies, the agro-weather relationship was still central to sectoral movements in output and inflation and had significant macroeconomic implications. In Germany the agricultural sector accounted for approximately 40% of GDP in 1870, declining to 23% by 1913. In Britain the sector accounted for 15% of GDP in the early 1870s, declining to approximately 6% by 1907. This major difference in economic structure between Britain and Germany allows us to glimpse into the implications of the observed agro-weather relationship in present day developing economies. The economic structure of Britain in the early 20th Century is comparable to the economic structure that evolves in most

of the major industrial countries after 1950. However, for many developing economies, the kind of economic structure we observe in Germany at the end of the 19th Century is relevant to the present era.

The paper is structured as follows: Section 1 outlines a statistical framework for modelling the effects of weather on sectoral inflation and considers the data being used in the analysis. Since the agro-weather price relationship is expected to be non-linear we employ semi-parametric models to estimate this relationship. Section 2 estimates the weather effect on British and German agricultural prices respectively. Section 3 quantifies the aggregate effect of weather shocks by considering the weighted effect of sectoral weather shocks on the GDP deflator.

1. MODELLING WEATHER EFFECTS ON AGRICULTURAL PRICES

The starting point of our methodology is that the effect of weather on agricultural prices is expected to be non-linear and asymmetric, if only because the effect of weather on agricultural output is observed to be non-linear (Solomou & Wu, 1999; Khatri et al., 1998). A classical approach for estimating this non-linear relationship is to use a low order polynomial, the coefficients of which are estimated by least squares. However, in using this approach, individual observations may exert a large effect on the shape of the estimated function. An alternative approach is the semiparametric smoothing approach, which relaxes the model assumptions in classical regression. Let,

$$y = \mathbf{x}\beta + g(z) + \varepsilon \tag{1}$$

where y is the dependent variable; $\mathbf{x}$ is the $p \times 1$ vector of linear economic explanatory variables; β is the coefficient matrix; $g(z)$ is the nonparametric function allowing for a non-linear relationship between y and z (in this case various measures of weather); and ε is an iid disturbance term. The effect of weather on prices, g, is expected to be non-linear, but of unknown form. An important property of the nonparametric estimation of weather effects is that the methodology does not assume an a priori form for the dependence of the response on the explanatory variables (an outline of the methodology can be found in Appendix 1; a fuller outline is found in Khatri, Solomou & Wu, 1998).

Our aim is to estimate the magnitude of the effect of weather on aggregate agricultural prices, which can be thought of as a weighted average of crop and livestock prices. Finding a relevant index for the weather conditions influencing the agricultural sector is not straightforward, partly because there does not exist a unique relationship between individual weather measures and agricultural output/prices. The impact of weather on agricultural output/prices depends on

a number of factors including rainfall, temperature, sunshine hours, soil type and wind speed (Oury, 1959). Selecting only one element of weather might thus be considered an over-simplification. An index of agricultural drought that relates these different weather inputs may provide a good summary measure of relevant information. The effect of weather on soil moisture levels during the growing period is a key mechanism through which weather conditions affect output. A combination of precipitation and evapotranspiration (evaporation from the soil surface and transpiration from plants) will determine soil moisture levels. Evapotranspiration itself will depend on climate, soil moisture, plant cover and land management (Thornthwaite, 1948; Oury, 1959).

A useful practical index of weather is the soil moisture level during the growing season. Rodda et al. (1976) concludes that soil moisture deficits (SMD) provide the best practical drought index. The most fundamental problem with this approach is the requirement of complex measurements needed to calculate the soil moisture level. Such data requirements limit the availability of soil moisture measurements over long-run time periods to a handful of areas. Extreme deviations from mean SMD in either direction (high values implying drought and low values implying excess moisture) are thus predicted to have adverse effects on output. Wigley and Atkinson (1977) calculate growing season SMD values for Kew back to 1698. In other work we have shown that estimation of the agro-weather production relationship for Britain gives similar results when using the SMD index, annual temperature and rainfall and growing period temperature and rainfall (Khatri, Solomou & Wu, 1998). For simplicity of presentation, here we focus on the results using temperature and rainfall information in the light that the results are not sensitive to the weather data used. Annual average temperature and total rainfall are employed as measures of contemporaneous weather conditions. Lagged effects are also considered; since crops are harvested in the autumn, the weather effects on crop output is likely to have a lagged effect on current crop prices. Thus, we also consider the effect of average temperature and total rainfall in the last growing period.[1]

To avoid the problem of spurious regression, it is necessary to determine the order of integration of the data series to be analysed. Tables 1–3 and Tables 4–6 report the results of ADF tests for the U.K. and Germany respectively. ADF tests suggest that over this period economic variables in logarithms are not trend stationary and are all integrated of the same order ($I(1)$), whereas all weather variables are stationary in levels ($I(0)$). We consider a very simple long-run model where agricultural prices are seen as being co-integrated with import prices and (in the case of Germany) agricultural tariffs.[2] The relevance of this relationship between import prices and domestic prices is discussed extensively in Blake (1992) and Lewis (1978). The empirical evidence suggests

Table 1. ADF Tests of U.K. Economic Series (1872–1913).

	*log*Agr. Prices	*log*Money	*log*Imp. Prices	Critical Value
Without trend				
ADF(0)	−2.23*	1.47	−2.08*	−2.94
ADF(1)	−2.20	0.33	−2.01	−2.94
ADF(2)	−2.15	0.81*	−2.02	−2.94
ADF(3)	−2.07	0.71	−1.90	−2.94
ADF(4)	−2.00	0.78	−1.90	−2.94
With trend				
ADF(0)	−1.10*	−3.85	−0.81*	−3.53
ADF(1)	−0.82	−4.42	−0.87	−3.53
ADF(2)	−0.93	−3.49*	−0.62	−3.53
ADF(3)	−0.91	−3.57	−0.88	−3.53
ADF(4)	−0.35	−3.46	0.47	−3.53

* suggested by the AIC.

Table 2. ADF Tests of U.K. First-differences of Economic Series (1873–1913).

	∇*log*Agr. Prices	∇*log*Money	∇*log*Imp. Prices	Critical Value
Without trend				
ADF(0)	−5.80*	−3.04	−4.90*	−2.94
ADF(1)	−3.30	−3.74*	−3.78	−2.94
ADF(2)	−2.54	−2.94	−2.34	−2.94
ADF(3)	−2.92	−2.85	−2.52	−2.94
ADF(4)	−2.78	−2.34	−2.56	−2.94
With trend				
ADF(0)	−6.82*	−3.06	−5.81*	−3.54
ADF(1)	−4.20	−3.85*	−4.92	−3.54
ADF(2)	−3.50	−3.08	−3.24	−3.54
ADF(3)	−4.44	−3.05	−3.80	−3.54
ADF(4)	−4.70	−2.52	−4.41	−3.54

* suggested by the AIC.

Table 3. ADF Tests of U.K. Weather Series (1872–1913).

	Annual Temp.	Annual Rainfall	Temp. May–Aug	Rainfall May–Aug	Critical Values
Without trend					
ADF(0)	−4.95*	−6.11*	−7.96*	−6.12	−2.94
ADF(1)	−3.08	−4.24	−5.03	−3.22*	−2.94
ADF(2)	−3.11	−2.05	−3.43	−2.64	−2.94
ADF(3)	−2.64	−1.96	−2.82	−2.75	−2.94
ADF(4)	−2.36	−1.55	−2.85	−3.07	−2.94
With trend					
ADF(0)	−5.58*	−6.35*	−8.06*	−6.49*	−3.53
ADF(1)	−3.66	−4.53	−5.20	−3.51	−3.53
ADF(2)	−3.71	−1.98	−3.60	−2.94	−3.53
ADF(3)	−3.26	−1.90	−2.97	−3.12	−3.53
ADF(4)	−2.97	−1.18	−3.02	−3.68	−3.53

* suggested by the AIC.

Table 4. ADF Tests of German Economic Series (1872–1913).

	*log*Agr. Prices	*log*Money	*log*Agr. ImportPrice	Agr. Tariff	Critical Value
Without trend					
ADF(0)	−0.91	0.87*	−2.63	−1.19*	−2.94
ADF(1)	−1.18	0.73	−2.88*	−1.03	−2.94
ADF(2)	−0.17	0.54	−2.86	−0.90	−2.94
ADF(3)	−0.93*	0.33	−2.73	−0.82	−2.94
ADF(4)	−0.72	1.05	−2.76	−0.71	−2.94
With trend					
ADF(0)	−2.01	−3.38*	−1.59	−2.67*	−3.53
ADF(1)	−2.24	−3.59	−2.12*	−2.43	−3.53
ADF(2)	−1.33	−3.53	−2.05	−2.24	−3.53
ADF(3)	−1.68*	−3.49	−1.60	−2.20	−3.53
ADF(4)	−1.43	−2.98	−1.61	−2.05	−3.53

* suggested by the AIC.

Table 5. ADF Tests of German First-differences in Economic Series (1873–1913).

	∇*log*Agr.Pr	∇*log*Money	∇*log*Agr. Import Price	∇Agr. Tariff	Critical Value
Without trend					
ADF(0)	−5.64	−6.02*	−4.28*	−6.90*	−2.94
ADF(1)	−6.07	−5.24	−3.41	−5.08	−2.94
ADF(2)	−3.17*	−4.47	−3.62	−4.07	−2.94
ADF(3)	−3.24	−4.65	−2.88	−3.72	−2.94
ADF(4)	−2.95	−3.19	−3.39	−3.17	−2.94
With trend					
ADF(0)	−5.98	−5.84*	−4.76*	−6.81*	−3.54
ADF(1)	−6.72*	−5.07	−3.98	−5.01	−3.54
ADF(2)	−3.63	−4.06	−4 41	−4.00	−3.54
ADF(3)	−3.94	−4.33	−3.77	−3.65	−3.54
ADF(4)	−3.90	−2.72	−4.56	−3.11	−3.54

* suggested by the AIC.

Table 6. ADF Tests of German Weather Series (1872–1913).

	Annual Temp.	Annual Rainfall	Temp. May–Aug	Rainfall May–Aug	Critical Values
Without trend					
ADF(0)	−4.76*	−6.82*	−6.68	−7.14*	−2.94
ADF(1)	−3.16	−3.84	−6.61*	−4.73	−2.94
ADF(2)	−3.20	−2.68	−4.27	−4.24	−2.94
ADF(3)	−2.16	−2.29	−3.81	−3.97	−2.94
ADF(4)	−2.08	−2.37	−3.41	−4.18	−2.94
With trend					
ADF(0)	−5.20*	−7.20*	−6.64	−7.24*	−3.53
ADF(1)	−3.58	−4.12	−6.72*	−4.89	−3.53
ADF(2)	−3.71	−3.00	−4.42	−4.38	−3.53
ADF(3)	−2.67	−2.63	−3.98	−4.13	−3.53
ADF(4)	−2.57	−2.75	−3.63	−4.41	−3.53

* suggested by the AIC.

a prima-facie case that domestic agricultural prices shared common trends with international prices, reflecting the integration of commodity markets at the end of the 19th Century.

Since weather variables are $I(0)$ whereas agricultural prices are $I(1)$, we estimate the effects of weather on the growth of agricultural prices (i.e. agricultural price inflation) using an error correction model. Table 7 reports the results of the Johansen cointegration tests for Britain. British agricultural prices and import prices are cointegrated.[3] Table 8 presents the Johansen cointegration tests for Germany treating import prices and tariffs as exogenous variables. The variables are cointegrated. Thus, in the long run domestic agricultural prices were being determined by changes in import prices and, in the case of Germany, domestic trade policy.

In using import prices as an important variable we should note that a number of processes determined import prices. Both Britain and Germany were on the gold standard during much of this period,[4] with their exchange rates pegged to gold. However, paradoxically, the period saw significant variations in nominal effective exchange rates (Solomou & Catao, 2000). Alternative exchange rate regimes, such as the silver standard and paper currencies, prevailed in many primary-producing countries – some of which witnessed considerable exchange rate variability (Ford, 1962; Nugent, 1973; Bordo & Rockoff, 1996). In this situation monetary policy in the periphery countries gave rise to nominal exchange rate variations that affected import prices. Variations in import prices

Table 7. Johansen's Test for U.K. Agricultural Price Cointegrating Vector (1873–1913).[5]

H_0	H_a	Statistic	Crit. Val. 95%	Crit. Val. 90%
λmax:				
r = 0	r = 1	10.46	11.47	9.53
λtrace:				
r = 0	r = 1	10.46	11.47	9.53

Table 8. Johansen's Test for German Agricultural Price Cointegration (1873–1913).[6]

H_0	H_a	Statistic	Crit. Val. 95%	Crit. Val. 90%
λmax:				
r = 0	r = 1	17.05	14.35	12.27
λtrace:				
r = 0	r = 1	17.05	14.35	12.27

also reflected the effect of real variables. For example, technological changes resulted in a large fall in shipping costs in the late 19th Century and the development of agricultural production in the 'New World' resulted in large productivity gains for the sector. Since the focus of this paper is on the effect of weather, which is assumed to have a short-term stationary effect, we do not focus on explanations of the long-run movements in import prices; instead we use these long run relationships to form appropriate models for analysing weather effects.

2. ESTIMATES OF AGRO-WEATHER PRICE EFFECTS

Britain

We estimate a semiparametric model of agricultural price inflation. The linear economic variables included are: (a) the growth of domestic money supply to capture macroeconomic effects on sectoral price inflation; (b) the growth rate of import prices, which follows directly from the long-run cointegration model between agricultural prices and import prices; (c) the lagged growth rates of agricultural prices, money supply and import prices to capture autoregressive and lagged exogenous effects; and (d) the error correction term from the cointegration model. In the nonparametric part, we include both the annual temperature/rainfall and the temperature/rainfall over last growing period.[7]

Table 9 presents the results of the best-fit semiparametric model, based on the Akaike Information Criterion.[8] There are two significant weather variables – annual rainfall (capturing a contemporaneous effect) and the rainfall over last growing period. Annual temperature is only marginally significant.[9] As shown in Figs 1–3, whereas the average annual temperature in the current year has a linear effect on agricultural price inflation, the response patterns of both the

Table 9. Statistics of U.K. Semiparametric GAM (1874–1913).[10]

Parametric Part	t-ratio	Pr (> | t |)
∇*log* Import Price	6.50	0.01
Lagged EC	–4.63	0.01
Annual Temperature	1.62	0.12
Nonparametric Part	Npar F-test	Pr(F)
s (Annual Rainfall, 3)	2.93	0.10
s (Last Growing Period Rainfall, 3)	5.10	0.01

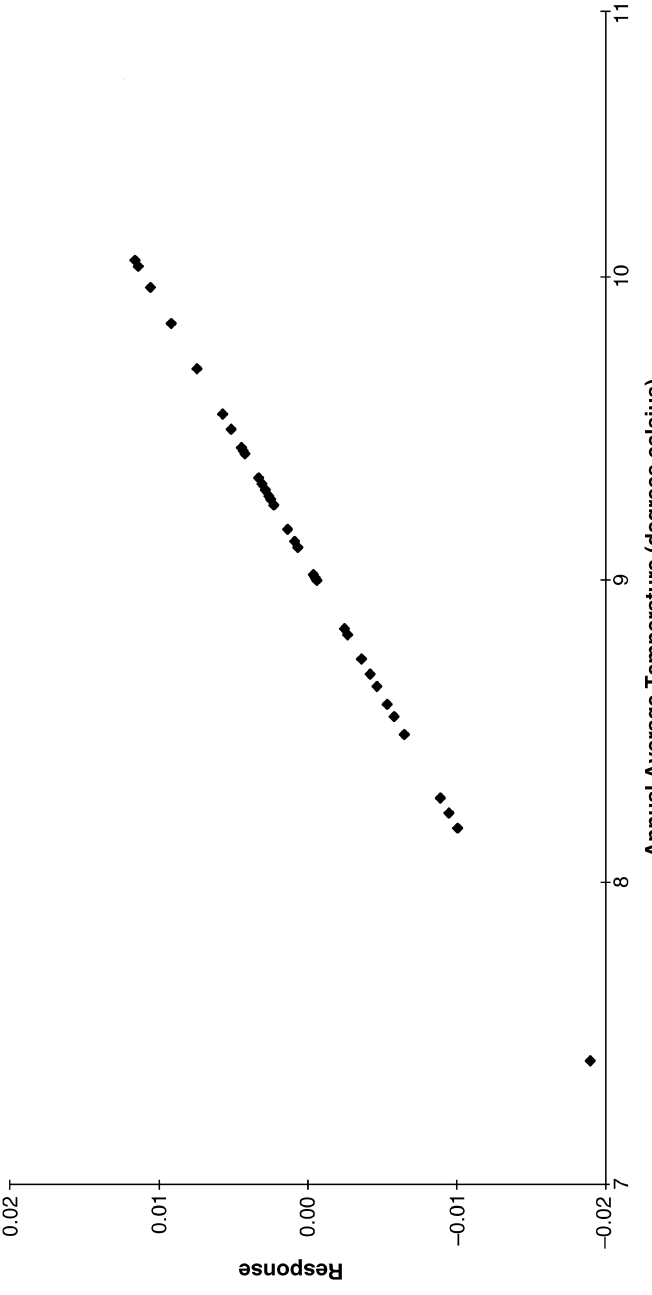

Fig. 1. Temperature Effect on U.K. Agricultural Price Inflation.

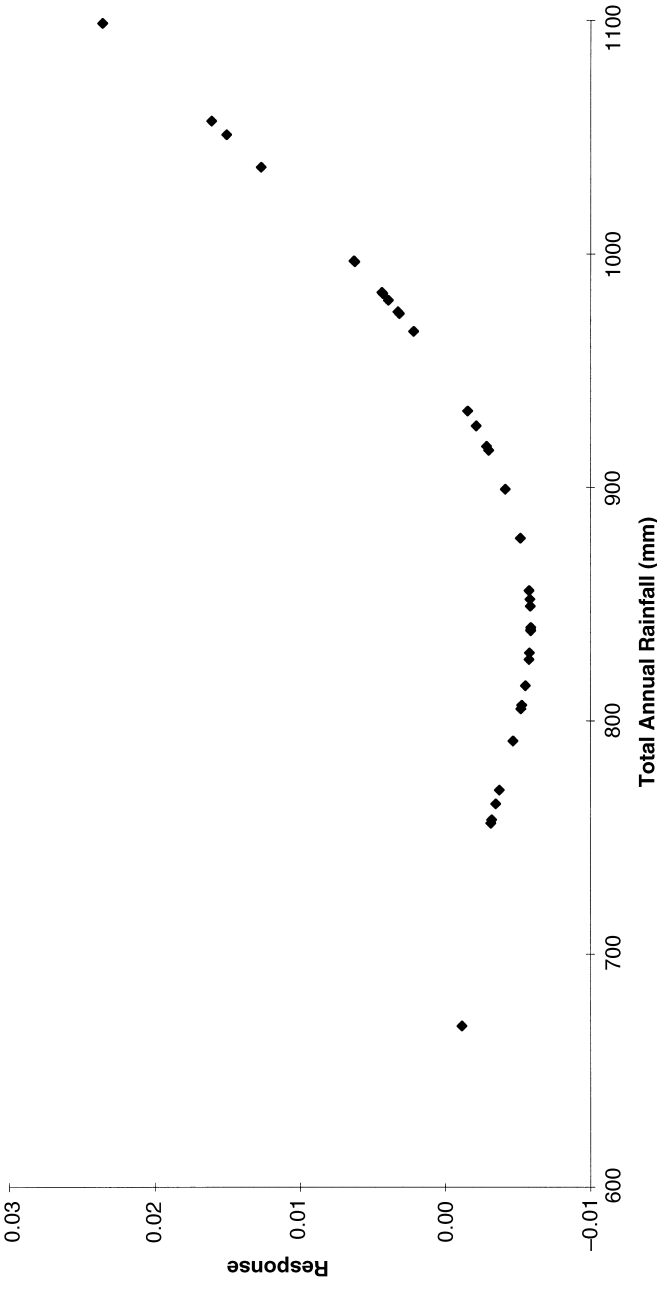

Fig. 2. Rainfall Effect on U.K. Agricultural Price Inflation.

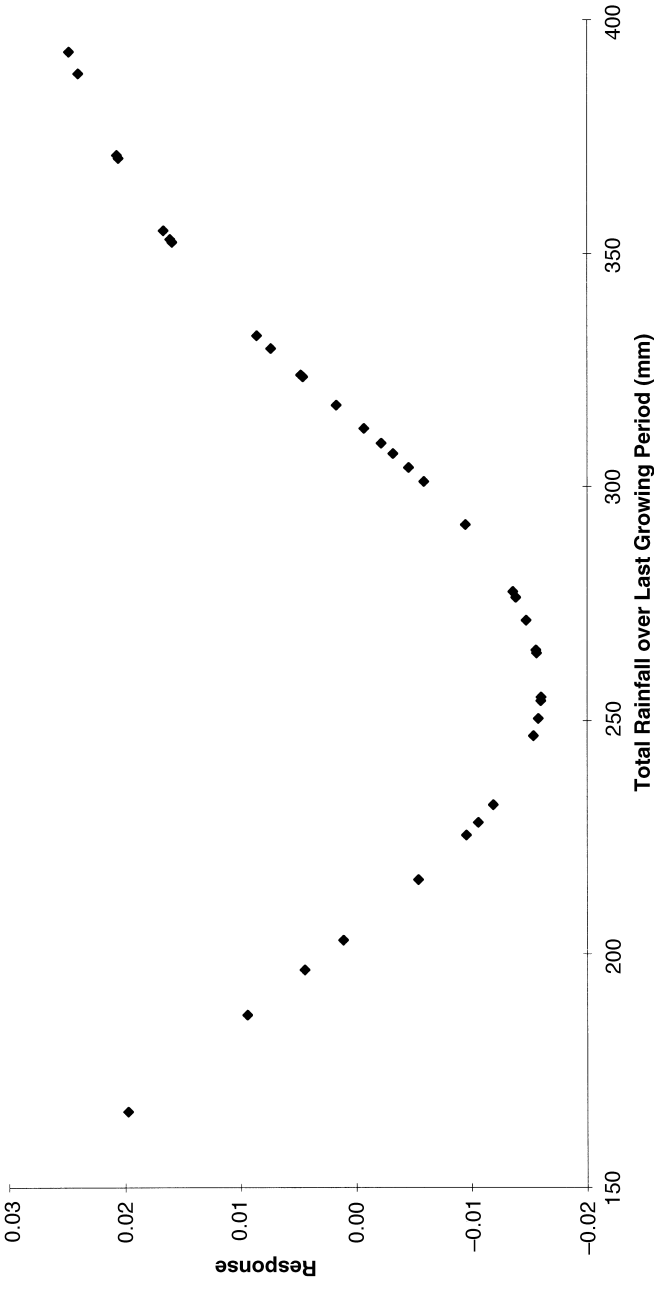

Fig. 3. Rainfall Effect on U.K. Agricultural Price Inflation.

total rainfall in the current year and the rainfall in last growing period are non-linear and asymmetric.

The semiparametric model explains 79.2% of the total variation of the U.K. agricultural price inflation. The weather effects account for 16.5% of the total variation. The total weather effect ranges from –3.0% to +5.0% around the average[11] (see Fig. 4). Although weather continued to have a marked effect on agricultural prices, the effect only explains a relatively small proportion of the total variation of agricultural price inflation. In contrast, weather had a relatively large effect on agricultural output (Khatri, Solomou & Wu, 1998), explaining approximately half the variations of agricultural production. Weather explains less than one sixth of the variations in agricultural price inflation; most of the variation of agricultural prices is explained by variations in import prices. However, weather continued to have an effect, even in an era of free trade. Another robust result is that weather had both contemporaneous and lagged effects on agricultural price inflation, with the lagged growing period rainfall having a significant non-linear effect on price inflation, with low and high rainfall extremes leading to inflationary effects. The existence of lagged weather effects and the fact that weather variations are cyclical adds cyclical impulses to agricultural price inflation rates.

Germany

We consider a similar semiparametric model for Germany.[12] Table 10 reports the results from the best-fit semiparametric model in terms of the Akaike Information Criterion. Three weather variables are statistically significant: annual temperature in the current year, annual rainfall in the current year and average temperature in last growing period. The estimated effect of the contemporaneous annual temperature is linear whist the effects of the annual

Table 10. Statistics of German Semiparametric GAM (1874–1913).[13]

Parametric Part	t-ratio	Pr (> | t |)
∇*log* Import Price	1.91	0.07
∇*log* Money	2.66	0.01
Lagged EC	–3.94	0.01
Annual Temperature	1.77	0.09
Nonparametric Part	Npar F-test	Pr(F)
s (Annual Rainfall, 3)	2.74	0.08
s (Last Growing Period Temperature, 3)	4.24	0.05

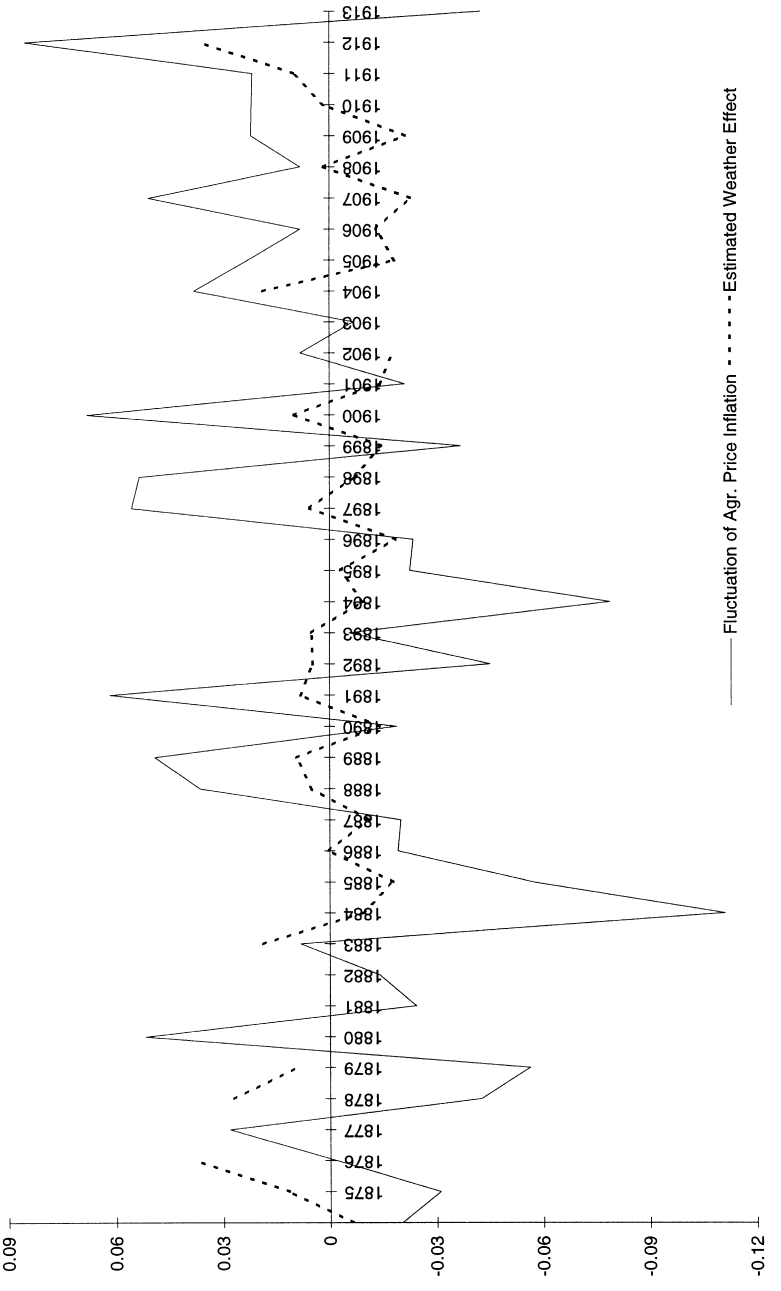

Fig. 4. Fluctuation of U.K. Agricultural Price Inflation and Estimated Weather Effect.

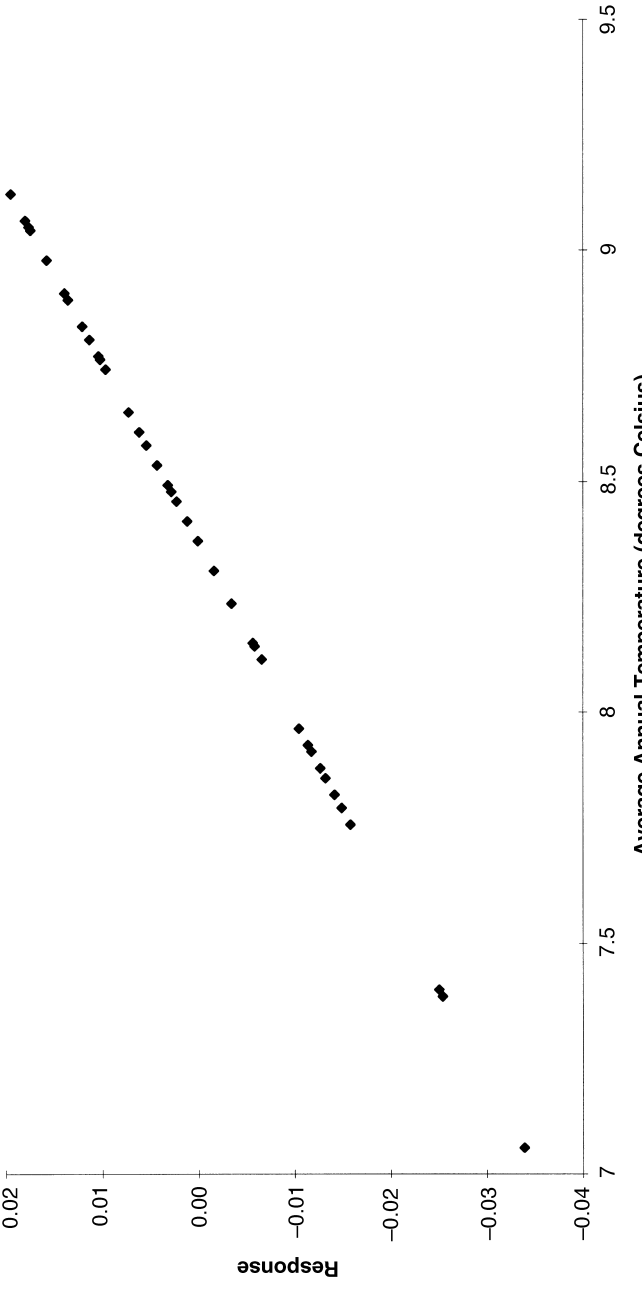

Fig. 5. Temperature Effect on German Agricultural Price Inflation.

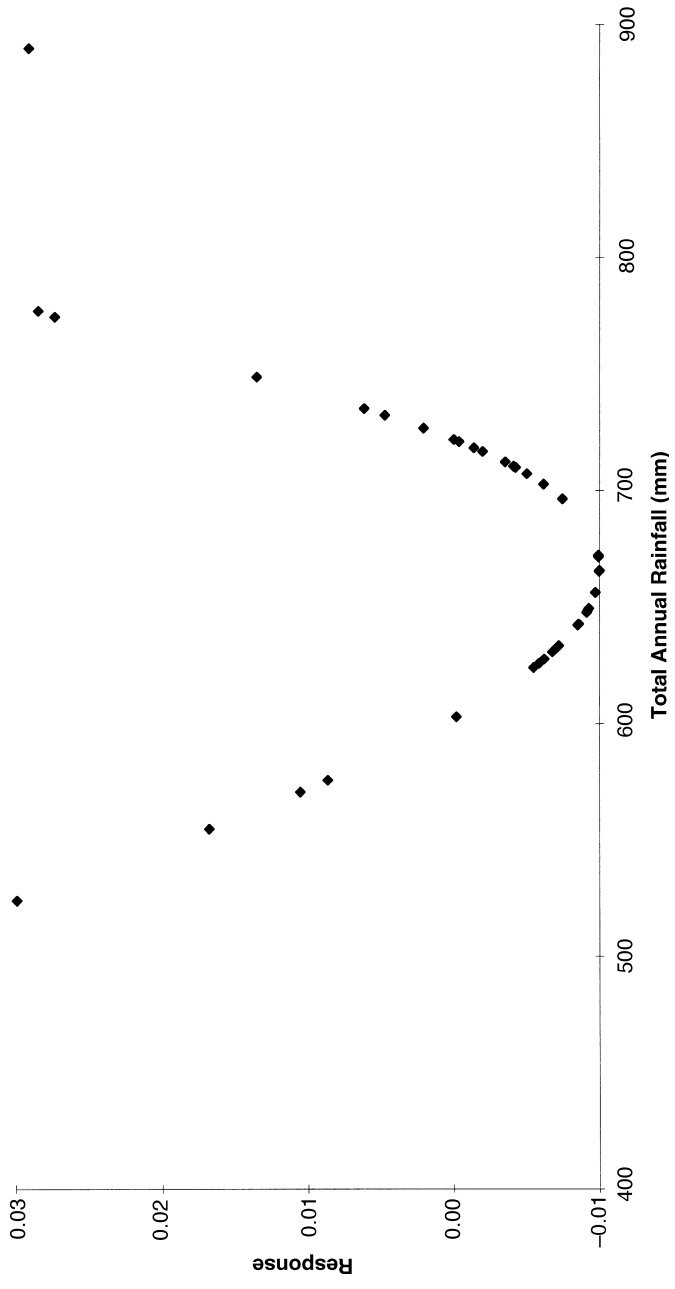

Fig. 6. Rainfall Effect on German Agricultural Price Inflation.

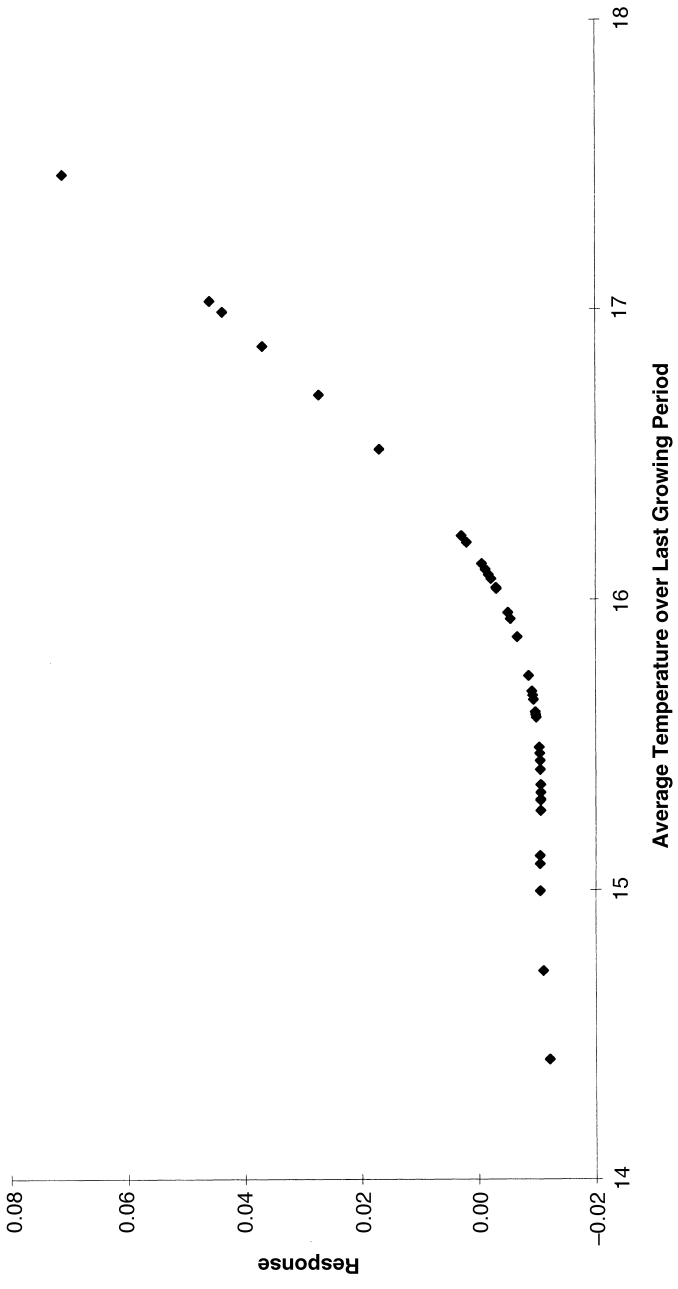

Fig. 7. The Effect of the Last Growing Period Temperature on German Agricultural Price Inflation.

rainfall and average temperature in the last growing period are non-linear.

The semiparametric model accounts for 66.0% of the variations in the growth of German agricultural prices. Weather effects account for 20.5% of the observed variations of agricultural price inflation. The range of weather effects on agricultural price inflation is –4.0% to +6.0% in Germany[14] (see Fig. 8) significantly higher than the estimates for Britain. Comparing the agro-weather output and price effects suggests that in Germany not only was the effect range larger on prices but the output and price effects are of comparable proportions: weather shocks explain about one fifth of the variations of German agricultural output (Solomou & Wu, 1999).[15] A similar proportion is reported here for prices. In contrast, in the case of Britain, weather variations explain over half the variations in agricultural output but only approximately one sixth of variation in price inflation.

3. WEATHER EFFECTS ON AGGREGATE INFLATION

During the period 1870–1913 weather shocks were important to the observed fluctuations of agricultural price inflation. The impact of these sector-specific effects on the macroeconomy will depend on the magnitude of the sector-specific inflationary effect and secondly, the relative weight of the sector in the macroeconomy (and, implicitly, changes in the sectoral shares over time). In this section we consider the aggregate effect of weather shocks by weighting the estimated effect using the sector's share in GDP, as a way of quantifying the impact of weather shocks on the GDP price deflator.

The sectoral shares in GDP are plotted in Fig. 9. In the case of Britain a combination of a relatively small weather effect and a relatively small (and declining) share for the sector in GDP suggests that the effect of weather shocks on aggregate price inflation was small. The range of weather effects on aggregate inflation during 1870–1913 was around –0.2% to +0.66% (see Fig. 10). For most of the period between 1880 and 1913 the effect range was around ±0.2%. Since the standard deviation of the inflation rate of the GDP deflator during 1870–1913 was 2.39%, the sector accounts for a relatively small proportion of aggregate domestic inflation.

In the case of Germany a very different picture emerges. The relatively large effect range of weather shocks on sectoral inflation and the large weight of the agricultural sector in GDP, result in a large effect on aggregate inflation. The inflation rate of the German GDP deflator ranged between –6.3% and +7.8%; the standard deviation of the inflation rate being 3.0%. The range of the weather effect on agricultural price inflation was –1.5% to +1.8%; the standard deviation

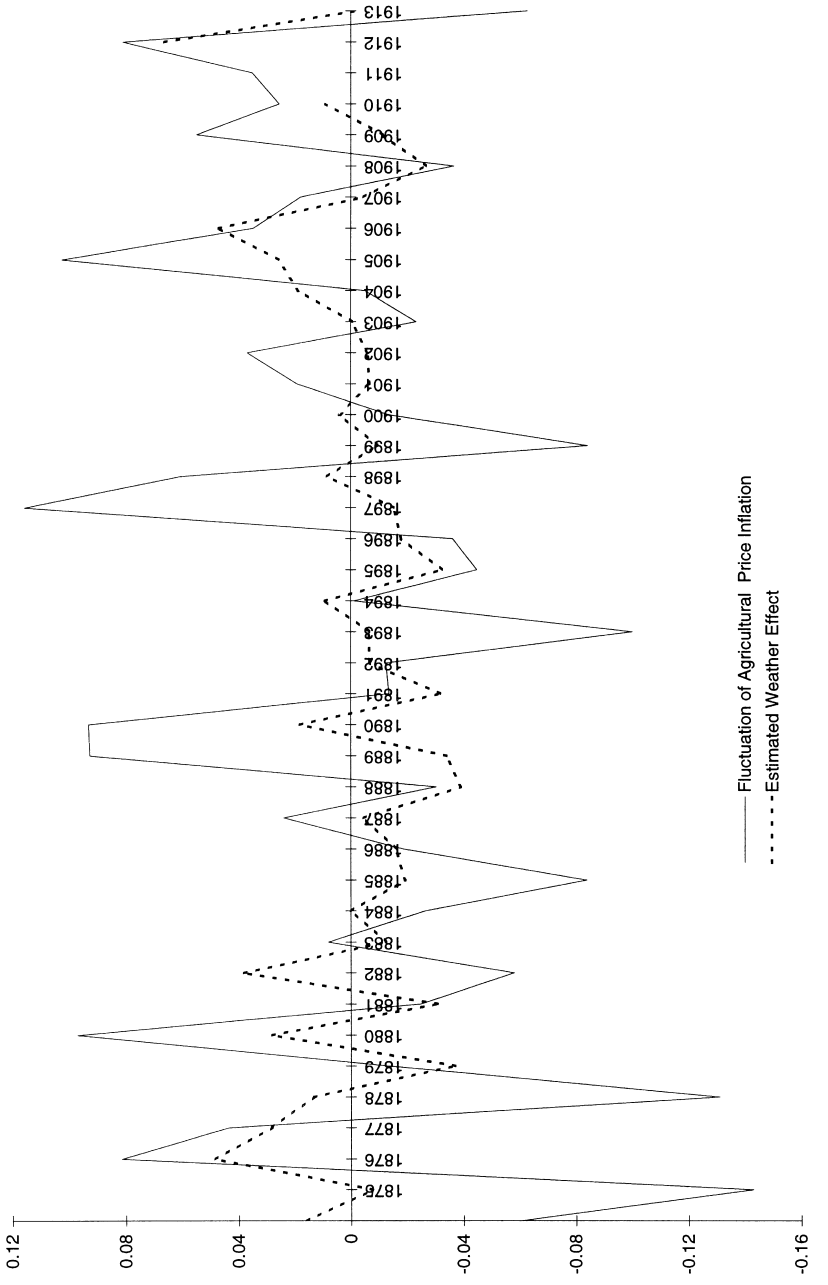

Fig. 8. Fluctuation of German Agricultural Price Inflation and Estimated Weather Effect.

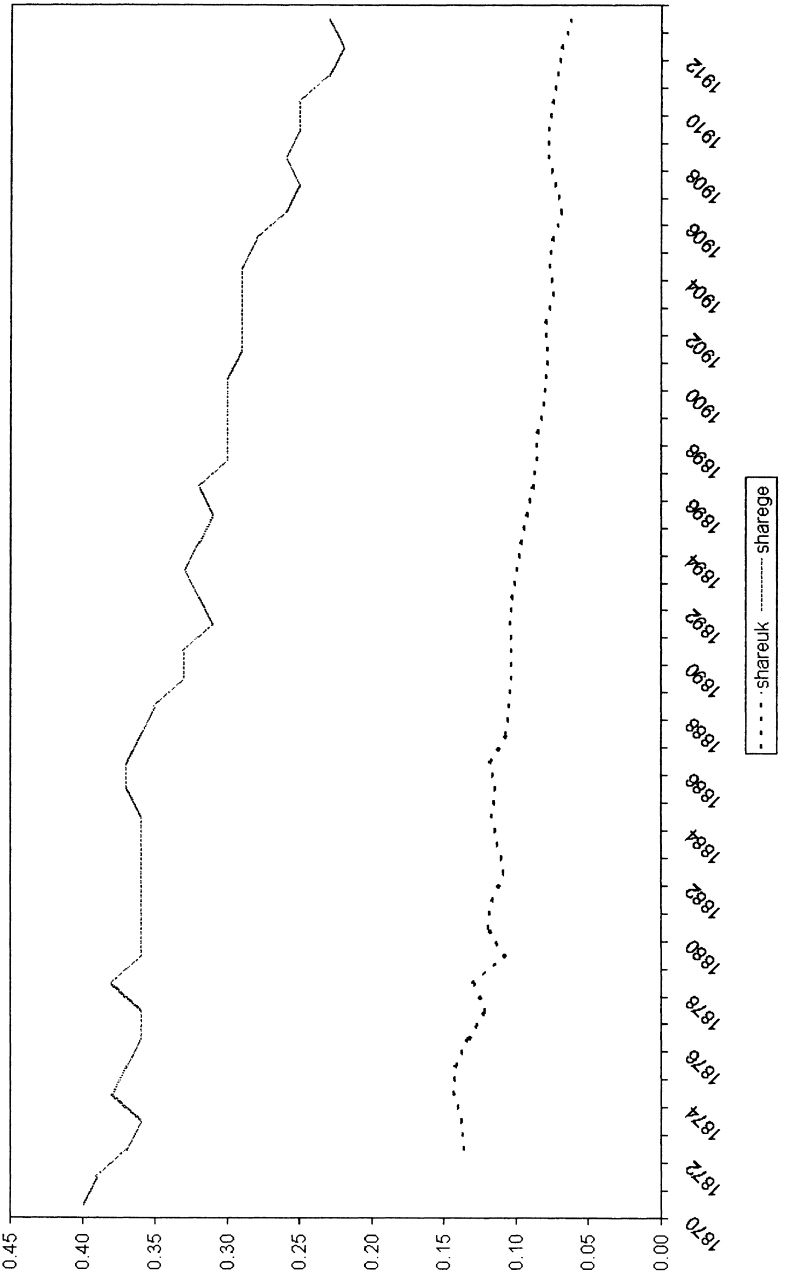

Fig. 9. Share of Agriculture in GDP.

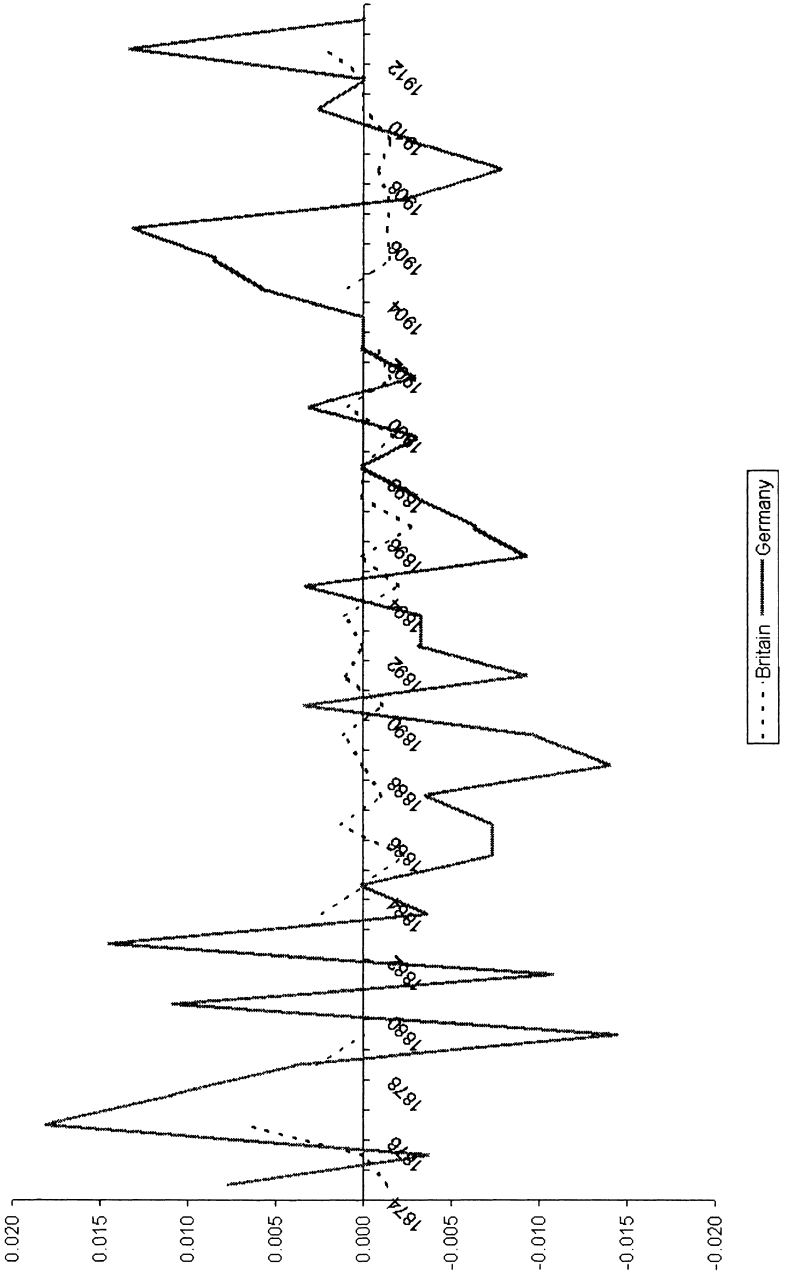

Fig. 10. Weighted Effect of Weather Shocks on GDP Price Deflator.

of the weather effect on aggregate inflation being 0.8%. Thus, weather shocks to agriculture can account for approximately one quarter of the variations in aggregate domestic inflation.[16]

CONCLUSIONS

Sectoral Inflation Rates and the Agro-weather Relationship
The agro-weather production relationship had significant effects on agricultural price inflation. In an era when aggregate inflation rates were low the agricultural sector saw larger variations, partly induced by weather effects and partly by large variations in import prices.

Agro-weather Effects are Cyclical
A number of processes added cyclical effects on agricultural price inflation. First, weather follows a cyclical path. Hence, the agro-weather linkages will generate cyclical effects on the sector. Secondly, weather has both a contemporaneous and lagged effect on agricultural prices, affecting the propagation mechanism of shocks.

The Macroeconomic Effects of Weather on Aggregate Prices
The two country comparisons reported in this paper illustrate that the macro effects of weather shocks remained large during the period 1870 to 1913. Britain was exceptional in that its economic structure differed from that of Europe; a very small agricultural sector and a free trade stance implied that domestic agricultural prices were mainly being determined by import prices. The results reported for Germany are likely to be more representative for the European economies, with large agricultural sectors and agricultural protection. The contrasting policy and economic structures for Britain and Germany also offer interesting insights into the agro-weather relationship of modern day developing economies. The results for late 19th Century Germany will be replicated in a similar way in modern day relatively closed developing economies.

NOTES

1. Because the rainfall data during this period are available only at a monthly frequency, we define the growing period for both countries as the duration May–August. In practice there will be some differences, which can only be captured with higher frequency data.

2. We also considered models allowing for more macroeconomic information, such as the money supply. However, such models were not co-integrated.

3. On theoretical grounds we assume that import prices are exogenous to domestic agricultural prices.

4. Britain was on the gold standard throughout 1870–1913 and Germany during 1879–1913.

5. Import prices are treated as an exogenous variable. The cointegration model was one of unrestricted intercepts and no trend in the VAR. Order of VAR = 1.

6. Agricultural import prices and agricultural tariffs are treated as exogenous variables. The cointegration model was one of unrestricted intercepts and no trend in the VAR. Order of VAR = 1.

7. We also considered the lagged weather effects using annual weather data. In the case of Britain only the lagged growing period weather information proved significant.

8. The statistical methodology we employ is within a general to specific framework. The initial models allowed for a wider set of economic and weather variables. The final reported results are based on model selection using the AIC (Akaike Information Criterion.

9. All three variables are retained because they jointly improve the fit of the semi-parametric model.

10. The sample excludes four observations with extreme annual rainfall larger than 1140mm or rainfall over last growing period larger than 460mm.

11. British agricultural price inflation rates range from –11.1% to +8.5% around the average.

12. The average agricultural tariff rate in Germany follows a step function. We therefore assume that the tariff has a long run impact on the price level rather than the inflation rate. Any effect on agricultural price inflation will be via the error correction component.

13. The sample excludes one observation with annual average temperature larger than 9.6 °C.

14. Over the period, the inflation rate of German agricultural prices is more volatile than the British rate, ranging from –14.3% to +11.6% around the average.

15. Using decomposed weather data the effect of weather shocks and cycles increases to one third of output variations. However, the limited degrees of freedom prevented us from using decomposed weather data in the estimated price models. Hence we compare the results from untransformed weather data.

16. Aggregate models of weather and inflation give similar results to this sectoral accounting methodology (results are available on request).

17. A specific agricultural import price index is not available. We use the total import price index on the assumption that the largest component of British imports was food and raw materials.

ACKNOWLEDGMENT

The Leverhulme Trust has supported the research for this paper.

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APPENDIX 1

Semi-parametric Modelling the Effects of Weather on Agricultural Prices

The semiparametric approach relaxes the assumptions behind classical regression models and offers a useful methodology for modelling non-linear relationships. The presentation here draws on the work of Engle et al. (1986). Let,

$$y = \mathbf{x}\,\beta + g\,(z) + \varepsilon \tag{1}$$

where y is the dependent variable; $\mathbf{x}$ is the $p \times 1$ vector of linear explanatory variables; β is the coefficient matrix; $g\,(z)$ is the nonparametric function allowing for a non-linear relationship between y and z; and ε is an iid disturbance term.

Denote y_t as log of agricultural prices, $\mathbf{x}_t$ as the vector of economic variables, β as the corresponding parameter vector for $\mathbf{x}_t$, and $\mathbf{z}_t$ as the vector of weather variables. Then, we can rewrite (1) as:

$$\begin{aligned} y_t &= y_t^e + y_t^w \\ y_t^e &= \mathbf{x}_t\,\beta + \eta_t^e \\ y_t^w &= g\,(\mathbf{z}_t) + \eta_t^w \end{aligned} \tag{2}$$

where y_t^e and y_t^w are the effects of the economic and weather variables respectively.

An important property of a smoother is its nonparametric nature: it does not assume a rigid form for the dependence of the response on the explanatory variable(s). With a set of observations, a possible criterion of 'fit' for the curve is the sum of squared residuals,

$$\sum_i [y_i^w - g\,(\mathbf{z})]^2 \tag{3}$$

where $g(\mathbf{z})$ is unconstrained. This measure is zero if $g(\mathbf{z})$ interpolates the data. However, such a curve will be too 'wiggly' to be consistent with priors on the shape of the function. As a way of deriving a smoother relationship we can add a term to (3) to penalise for the lack of smoothness. There are many different ways of measuring how 'rough' the curve g is. If g is twice differentiable, an intuitively appealing way is to calculate its integrated squared second derivative on its definition interval. The cubic spline is defined for the case where the roughness penalty is the integral of the squared second

derivatives of $g(\mathbf{z})$. In this case the penalised least squares estimator is to minimise the cost function

$$S(g) = \sum_i [y_i^w - g(\mathbf{z})]^2 + \lambda \int [g''(\mathbf{z})]^2 \tag{4}$$

Thus, the cost $S(g)$ of a particular curve is determined not only by its goodness-of-fit to the data as quantified by the residual sum of squares but also by its roughness measurement. Such smoothness priors represent information that the unknown function does not change slope abruptly. λ represents the 'rate of exchange' between residual error and smoothness. If λ is zero (i.e. no smoothness penalty) the solution is any interpolating set of functions whose evaluations satisfy (3) above. On the other hand, if l goes to infinity, the penalty term goes to infinity unless the second derivative is zero (i.e. unless each g is linear, allowing estimation using standard linear least squares).

A linear model is additive in the predictor effects. Hence, once we have fitted a linear model we can examine the predictor effects separately, in the absence of interactions. For analytical convenience we assume that y_t^w is estimated using a general additive model (GAM), which retains the additive feature for non-linear predictors. Thus, the effect of weather, generalising to a number of weather variables, can be presented as

$$y_t^w = \sum_k g_k(z_{kt}) + \eta_t^w \tag{5}$$

where the g_k is a univariate function for each predictor variable.

Within the GAM framework, there are a total of $p + q$ explanatory variables: a p-vector of linear variables and a q-vector of splined variables. Thus, the cost function of the partial spline can be rewritten as

$$\begin{aligned} S(\beta, g) &= (\mathbf{y} - \mathbf{X}\beta - \sum_k \mathbf{g}_k)^T \mathbf{W}(\mathbf{y} - \mathbf{X}\beta - \sum_k \mathbf{g}_k) + \sum_k \lambda_k \int g_k''^2 \\ &= (\mathbf{y} - \mathbf{X}\beta - \sum_k \mathbf{g}_k)^T \mathbf{W}(\mathbf{y} - \mathbf{X}\beta - \sum_k \mathbf{g}_k) + \sum_k \lambda_k \mathbf{g}_k^T \mathbf{K}_k \mathbf{g}_k \end{aligned} \tag{6}$$

where, having T observations, $\mathbf{y}$ is the $T \times 1$ vector of y, $\mathbf{g}_k$ is the $T \times 1$ vector of g_k, $\mathbf{K}_k$ is a quadratic penalty matrix for corresponding predictor z_k. Each function is penalised by a separate constant λ_k. This function is easily minimised to give the estimates of the parameters β and the vector g. To select the optimal λ, Engle et al. (1986) suggest a generalised cross-validation (GCV) criterion:

$$GCV = \frac{RSS_\lambda}{(1 - K/T)^2} \tag{7}$$

where RSS_λ is the residual sum of squares for the given λ, K is the equivalent number of parameters $\mathrm{tr}(\mathbf{A}(\lambda))$, and T is the number of observations.

APPENDIX 2: DATA SOURCES

Britain

The weather data relate to daily central England temperatures (Parker et al., 1992) and monthly central England rainfall (Wigley et al., 1984). The following economic series were used:

(a) The agricultural price index is the Sauerbeck Price index reported in Mitchell (1962);
(b) Import prices are from Feinstein[17] (1972, Table 64);
(c) The money supply, M3, from Capie and Webber (1985).

Germany

The temperature series is calculated from available station records in the file ADVANCE-10K, downloaded from the homepage of the Climate Research Unit at the University of East Anglia. The ADVANCE-10K contains the station emperature data for the E.U. research project "Analysis of Dendrochronological Variability and Associated Natural Climates in Eurasia – the last 10,000 years" (ref. no. ENV4-CT95-0127). The following stations are included: Leipzig, Dresden, Jena, Erfurt/Bindersleben, Kiel, Hannover, Berlin, Frankfurt a Main, Darmstadt, Bayreuth, Karlsruhe, München/Riem, Friedrichshafen and Hohenpeissenberg.

The rainfall series are calculated from the available records of the following German stations: Bamberg, Berlin-Dahlem, Emden-Hafen, Gutersloh, Halle, Husum, Kalkar, Lingelbach, Loningen, Mergentheim, Regensburg and Trier-Petrisberg (source: CD-ROM "World Climate Disc: Global Climate Change Data" by the Climate Research Unit at the University of East Anglia).

The Following economic data were used:

(a) Agricultural prices are from Weber (1973);
(b) Money supply figures are from Mitchell (1992). An aggregate series is constructed as the sum of the three components: Banknote Circulation, Deposits in Commercial Banks and Deposits in Savings Banks;

(c) Agricultural import prices are calculated from Desai (1968, Table A24). The index is constructed as the average of the import price of food grains and the import price of other food, drink and tobacco. The weights used are taken from Desai, 1968, Table C.1;
(d) Agricultural tariff rates are the average tariff rates on pigs and crops. This is calculated using Webb (1982).

AGRICULTURAL LABOR MARKET INTEGRATION IN THE ANTEBELLUM NORTHEAST: EVIDENCE FROM TWO NEW YORK FARMS

John E. Murray

What determined the value of labor in the past? While acknowledging the power of custom and social obligation to affect terms of exchange, this essay provides suggestive evidence that efficient markets for short and long term farm labor were flourishing in antebellum New York State. The remarkable aspect of this claim is that the hiring was done by people who to outward appearances had not the slightest desire to entangle themselves in external market relations. These were Christian communalist sectarians known as the Shakers, people who removed themselves from the World (their term for everywhere outside Shakerdom) to maintain a spiritual purity. Even so, systematic variations in contract characteristics, wage premia, and wage correlation over time seem to have arisen more from labor market conditions in the northeastern United States rather than local moral-economic considerations.

The Shakers were a Christian communal group.[1] Some of their distinctive beliefs included the existence of a male and female Godhead, from which followed sexual equality, and continuing revelation guided by active communication between Believers (a Shaker term for members of the sect) and denizens of the spirit world. Practices of the Society (their official name is the United Society of Believers in Christ's Second Appearing, the second appearing being

Advances in Agricultural Economic History, Volume 2, pages 145–161.

ISBN: 0-7623-1001-4

in the body of their foundress, an illiterate Englishwoman named Ann Lee) included pacifism, celibacy, confession of sins to elders, and joint or communal ownership of the Society's assets. Each Shaker received the same return for his or her labor: room, board, clothing, and the experience of divine proximity in a community of like minded Believers. From the handful of English Shakers who arrived in America in 1774, the Society grew to number about 4,000 by 1840, living in 18 communes that covered an arc from western Kentucky to Maine. This essay will concern the Shaker communities at Groveland, New York, which was about 30 miles south of Rochester, and New Lebanon, New York, about 20 miles east of Albany.

Leading Shakers regretted their need to hire non-member labor. Elders detested their lack of belief in Shakerism and feared their occasional rowdiness. When the South Union, Kentucky, Shakers built a new office in March and April 1841, the trustees ordered that the doors and windows be made in Louisville and sent to South Union "so as not to be compelled to have too many hirelings about."[2] Hired hands were a necessary evil to Isaac Newton Youngs, scribe of the New Lebanon Shakers. In his enormous manuscript history of the Society, he described the many businesses of the New Lebanon Shakers and observed, "In order to carry on all those concerns and to do our own farming and building, we are under the necessity to hire much help of the world without, which we are willing all should know is undesirable to us, and injurious to our spiritual travel." By the turn of the century, drunkenness of hired men was a frequent complaint at several communities.[3]

When the journalist Charles Nordhoff surveyed the Society in 1874 he reported opposing opinions on the hiring of outsiders. The New Gloucester, Maine, Shakers were pleased that children of nearby farmers who had once been hired hands of the Shakers were becoming promising young members of the Society. However, the leading Eastern Elder, Frederick Evans of New Lebanon, described the hands as a burden because the Society assigned its ablest members to supervise them. Most Shaker leaders found that the necessity to hire non-members outweighed their deleterious effects. According to figures collected by Nordhoff, the hired hands so disliked by Elder Evans were employed at every Shaker community, in some places more intensively than others. The ratio of hands to Believers ranged from 1 to 50 at Canterbury, New Hampshire, to over 1 to 5 at Watervliet, New York.[4]

Along with the hiring of non-member labor came the responsibility of recording the frequency of their employment, the tasks they performed, and the wages they were paid. As a result, some Shaker communities such as New Lebanon and Groveland provide remarkably full sets of data on hired labor.[5]

Entries in Shaker account books provide date of payment, number of months and days of labor, the value of the wage paid, and occasional references to debits accrued by the workers as they bought items from the Shakers.

It is useful to distinguish between workers hired by the day and by the month, as these seem to have been separate labor markets in the antebellum United States, the distinction being made according to the frequency with which the workers were paid.[6] Figure 1 shows the total number of adult work days per year provided by hired hands and the share of these work days provided by monthly laborers. The number of work days per year increased slightly over the time covered by the account books. The share of monthly labor, which is given here by a moving average, declined up to the late 1840s and then recovered and stabilized at about 70%. The years around 1848 clearly saw a large increase in the number of day laborers hired, and this occurred at both communities. I have not been able to determine the reason for this anomaly.[7]

The dates of these records fill an implicit gap in our understanding of Shaker history. Stein dated the onset of hiring outsiders at Groveland to 1860, but the

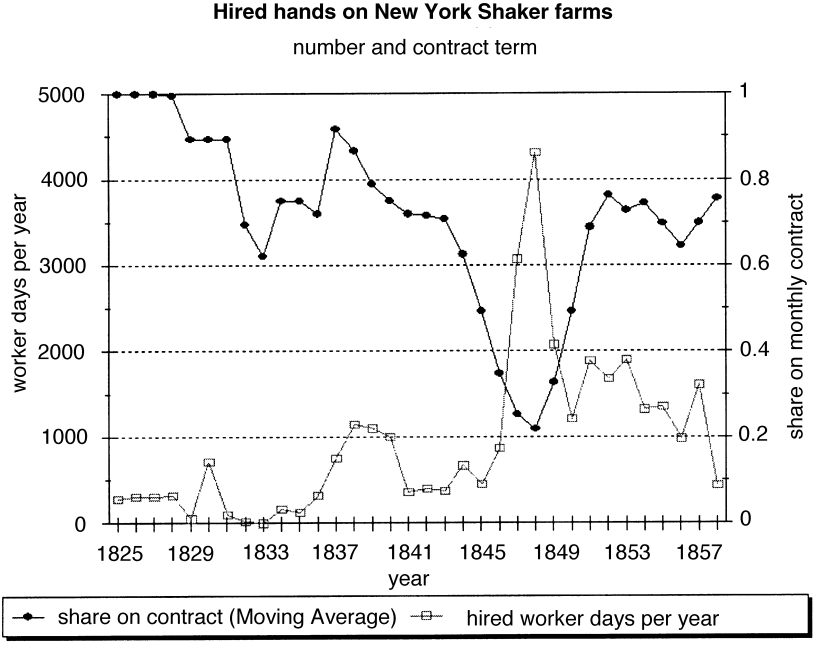

Fig. 1.

Groveland Shakers had been hiring non-Shaker laborers from a much earlier date.[8] The Shakers had initially settled on the Sodus Bay of Lake Ontario, and then relocated the entire community to Groveland during the year and a half after January 1837. The first monthly wages were paid to a hired hand in October 1837 for unspecified "work," and hired labor was employed regularly thereafter. The quantitative record thus aids in establishing that the use of hired labor was a long-standing practice there, and should help dispel the notion that hiring of hands was associated with Shaker decline.[9]

At New Lebanon, contract labor can be documented as early as the middle 1820s. The antebellum period in general, and the years 1837–1850 in particular, are sometimes referred to as a "golden age" of Shakerism, especially for New Lebanon.[10] During this period the New Lebanon Shakers enjoyed economic prosperity and growing intensity in their spiritual activities. Thus, even during what some would consider the community's best days, contract labor from the World was employed. The presence of such non-member workers who were hired from the outside coincided with, rather than thwarted, communal growth and prosperity, even in religious terms.

MONTHLY WORKER WAGES

Table 1 gives summary statistics of information on contracts and workers culled from the monthly worker account book entries. Tasks of monthly workers at Groveland were grouped into three categories: *carpenter* for those described as carpenter or joiner, *miller* for the many different mill related tasks, and *laborer* for the remaining descriptions of "labor" or "work." About a fifth of Groveland contract workers provided skilled labor, either at a carpentry or joinering or a mill related task. Skills specified in the sample of monthly New Lebanon workers included milling (24%) and blacksmithing and hatting (5% together); all other entries were for unspecified work or labor. About half of the New Lebanon monthly workers were required to sign a receipt book for their wages, so it is possible to determine the signature literacy of these workers. Five of 26 monthly workers (19%) were unable to sign their name, a high proportion in an era when the census reported literacy rates of 95% or so among male New Yorkers.[11]

To calculate average wages, only dollar payments, whether cash or accounting IOUs, were included. That is, those few cases in which the Shakers compensated their workers with in-kind payments such as a saddle, whiskey, shoes, and bricks, were omitted. Since the workers were paid only after having worked several months, we can consider the duration of employment as constituting an implicit contract. The average length of contracts at Groveland was just over

Table 1. Sample Characteristics of Contract Monthly Workers.

	Groveland, N. Y., 1837–1858		New Lebanon, N. Y., 1825–1860	
Variable	Mean	Standard deviation	Mean	Standard deviation
monthly wage	$15.86	5.52	$13.51	4.77
blacksmith/hatter	0.00		0.05	
carpenter/joiner	0.08		0.00	
miller	0.11		0.24	
unskilled labor	0.82		0.69	
literate	N A		0.36	
duration of contract	2.99	3.29	7.12	8.66
1820s	N A		0.15	
1830s	0.07		0.30	
1840s	0.53		0.08	
1850s	0.40		0.47	
N	134		59	

three months, while the New Lebanon contracts were somewhat longer, lasting on average over seven months. Elsewhere, contemporary Massachusetts farm labor contracts averaged five to six months in duration.[12]

The Groveland Shakers paid their monthly workers at rates somewhat above those paid by other employers, but the New Lebanon Shakers did not. The Groveland mean monthly pay of $15.86 was well above Lebergott's estimates of $10.00–13.00 for New York at this time.[13] McNall found that by the mid-1840s the monthly rate for hands in the Genesee Valley – a region of New York that included Groveland – was also in the range of ten to thirteen dollars a month. Days off there were deducted at a rate of 50 cents a day, which implies a pay rate of thirteen dollars a month. Bidwell and Falconer extended the pay range to $10–15 a month by the end of the 1840s. The New Lebanon Shakers paid, on average, thirteen and a half dollars a month to its contract work force, well within this range, although slightly higher than Lebergott's estimates.[14]

The higher Groveland Shaker wage could have been due to simple supply and demand factors. McNall reported numerous Genesee Valley farmer complaints about the scarcity of hired labor, especially at harvest time. Brooks made similar inferences about the region in New York just to the west of Groveland. The Groveland Shakers may have experienced the same acute labor shortages as did neighboring farms. Stein and Wisbey both described the community as being undermanned in the late antebellum period. The wage premium for long term workers may thus have been a symptom of the

community's historic need for hired manpower, or of a chronic shortage of labor in the Genesee Valley, or both. Testing the association between wages and contract length, discussed below, lends support to a role for some kind of labor shortage.[15]

To determine influences on the wages paid to monthly labor, hedonic wage regressions were estimated. The dependent variable was the natural log of monthly wages. Since each regression includes indicator variables for decades, which adjusted for long term inflationary or deflationary changes, logarithm of nominal wages rather than real wages was used as the dependent variable. Coefficient estimates give the percentage change in nominal wages associated with each independent variable. Wages for Shaker monthly laborers varied systematically according to characteristics of the worker and the contract, providing evidence of the sophistication with which the Shakers approached factor markets.

Table 2 gives the results of these regressions. Skill premia were noticeable at both locations. At Groveland, carpenters and mill workers received wages two-thirds and two-fifths again as much as common laborers, respectively. At New Lebanon, blacksmiths and hatters were paid half again as much as laborers. A skill premium estimated by Margo and Villaflor in the Northeast at this time – albeit not among farm workers – was one-half to two-thirds the unskilled wage, about the same as that paid by the Shakers. Although the New Lebanon Shakers hired their monthly workers to perform mostly manual labor, a statistically significant premium for literacy of about one-fifth was detected, suggesting that literacy may have stood as a proxy for other work related habits, or perhaps that literacy was in fact useful in a rural setting.[16]

The Groveland Shakers paid a premium of about 2% for each additional month for which a worker was willing to extend his contract. One explanation for this premium is based upon the possibility of labor shortages in the Genesee Valley. Whether greater duration of employment induced a wage premium or discount is determined in part by the expectations and risk aversion of each of the employer and the worker. If the employer fears being unable to find workers in the future more than the worker fears being unable to find employment, longer term contracts will pay a premium to lock in worker availability. In the Groveland case, wage premia for longer term workers are consistent with the claims that this region was chronically short on hired manpower. Wage premia in exchange for longer commitments by workers suggest that the Groveland Shakers' strong demand for hired men predated the Census of 1860, which found 33 males aged 14–80 operating a farm of some 1800 acres.[17] Thus dependence on hired labor was typical of Groveland's agricultural operations during its earlier, more prosperous years as well as its later declining years.

Table 2. Wage Regressions for Contract Monthly Workers.

	Groveland, N. Y., 1837–1858			New Lebanon, N. Y., 1825–1860		
Variable	parameter	std error	p-value	parameter	std error	p-value
intercept	2.34	0.05	0.0001	2.33	0.25	0.0001
blacksmith/hatter	na			0.49	0.26	0.07
carpenter	0.66	0.07	0.0001	na		
miller	0.43	0.08	0.0001	0.06	0.21	0.79
literate	na			0.23	0.11	0.04
months worked	0.02	0.006	0.0005	–0.004	0.007	0.59
harvest	na			0.38	0.20	0.06
spring	0.05	0.05	0.38	na		
summer	0.38	0.06	0.0001	na		
fall	0.08	0.05	0.13	na		
1820s	na			0.41	0.30	0.18
1830s	0.25	0.07	0.001	–0.13	0.24	0.58
1850s	0.13	0.04	0.001	0.14	0.24	0.58
R^2	0.62			0.34		

Notes: Dependent variable is logarithm of monthly wage. Seasonal dummies are for month or season in which contract ended. Omitted categories: unskilled, winter, literacy unknown or illiterate, 1840s. Each observation was weighted by the number of months at a given pay rate and task.
Sources: Shaker manuscripts. See text.

Premia paid by season reflected changing demands for labor through the farm year. Indicator variables were defined in terms of the season in which the contract ended. The Groveland Shakers paid a premium of over a third to summertime workers relative to winter workers. Since the New Lebanon contracts were so long and to conserve degrees of freedom, only one seasonal indicator variable, for contracts ending in July, August, or September, was included in the regression. The skill premium for contracts ending during this time, 38%, was identical to that paid to Groveland summer workers. As noted below, this is consistent with seasonal premia paid to Shaker and other day laborers at that time.

DAILY WORKER WAGES

The other common form of wage labor was that hired by the day. Account books from the Shaker Community at Groveland show that 2105 payments were made to individual workers for daily labor between 1837 and 1858.[18] These

were condensed into observations that consisted of month, year, daily wage, task, number of days worked at that task and wage in that month, and number of payments to individual workers. For example, payments for the following days of harvest work were made in August 1837: 8 payments at 10/ (where 8/ = \$1) per day for a total of $12^1/_2$ days of unspecified work, and 7 payments at 8/ per day for a total of 10 days of unspecified work. These combined to make two observations, one at each wage rate. This procedure yielded 797 observations. The number of days worked in each observation was used to weight observations in the regressions.

A few entries were specifically done by youths, who commonly were hired with their fathers as indicated by "work by his son [name]." These boys were always hired at relatively low wages, and were deleted to avoid contaminating the sample of adult men with the few payments to much less productive boys. The use of boys' labor was consistent with Bidwell and Falconer's observation that hired hands in the northeast were typically orphans or children of nearby poorer farmers.[19]

The day workers were occupied with nearly every conceivable task that operation of a large, diversified communal farm could require. One hundred thirty three different tasks were specified. Unspecified work or labor composed 322 observations, or about 42% of the sample (Table 4). Mill related tasks, such as "at the mill," "at the mill race," "fix mill," "in flouring mill," "millwright," and "tending mill" accounted for 8% of the sample. Mason work, which included "cutting stone," "drawing flagstone," "laying brick," "laying stone wall," "quarrying stone," and "tending mason," as well as "mason" and "mason work" described another 76 or 9% of the sample. Work with teams of horses or oxen made up two percent. The category "harvest" consisted of the tasks "harvest" and "harvesting," but inferences concerning harvest work were also based on other harvest-time occupations as described below. Many occupations had too few mentions to justify a separate dummy variable, so the "assorted" category includes, among other tasks, "grubbing," "loading boat," "shovelling," and the mysterious "work in storm."[20]

Figure 2 shows the frequency with which the Groveland Shakers employed their day laborers by month. In a typical year, demand for hired labor was greatest in July through September. The peak number of worker days for those doing unspecified labor was in September, while those with specified jobs were most commonly employed in July, which was also an important harvest month. This is not surprising for a largely agricultural organization, and in fact the monthly employment of hands at a nearby Genesee Valley farm shows a similar pattern.[21]

A much smaller sample of daily wages from New Lebanon is also available, from 1825–1860. The vast majority of these observations consisted of payments

Table 3. Sample Characteristics of Day Workers.

	Groveland, N. Y., 1837–1858		New Lebanon, N. Y., 1828–1861	
Variable	Mean	Standard deviation	Mean	Standard deviation
mean wage	$0.92	0.42	$0.71	0.42
blacksmith	0.01		0.08	
mason	0.09		0	
carpenter	0.10		0	
miller	0.08		0	
teamster	0.02		0	
haying	0.04		0	
harvest	0.05		0	
assorted	0.23		0.08	
unspecified	0.42		0.84	
spring	0.21		0.34	
summer	0.39		0.25	
fall	0.24		0.25	
N	797		62	

Sources: Shaker manuscripts. See text.

Table 4. Wage Regressions for Day Workers.

	Groveland, N. Y., 1837–1858			New Lebanon, N. Y., 1828–1861		
Variable	parameter	std error	p-value	parameter	std error	p-value
intercept	–0.23	0.06	0.0002	–0.50	0.23	0.04
blacksmith	0.46	0.11	0.0001	0.68	0.28	0.02
mason	0.73	0.04	0.0001	na		
carpenter	0.44	0.03	0.0001	na		
miller	0.76	0.04	0.0001	na		
teamster	0.91	0.08	0.0001	na		
haying	–0.16	0.05	0.002	na		
harvest	0.45	0.04	0.0001	na		
assorted	0.34	0.03	0.0001	0.61	0.25	0.02
unspecified	omitted			omitted		
spring	0.05	0.03	0.07	0.25	0.21	0.23
summer	0.14	0.03	0.0001	0.43	0.21	0.05
fall	0.04	0.03	0.13	0.27	0.20	0.18
R^2	0.68			0.30		

Notes: Dependent variable is log of daily wage. Groveland regression included dummy variables for year which are not reported here. New Lebanon regression included dummy variables for decade which are not reported here. Each observation was weighted by the number of days at each pay rate and task.

Sources: Shaker manuscripts. See text.

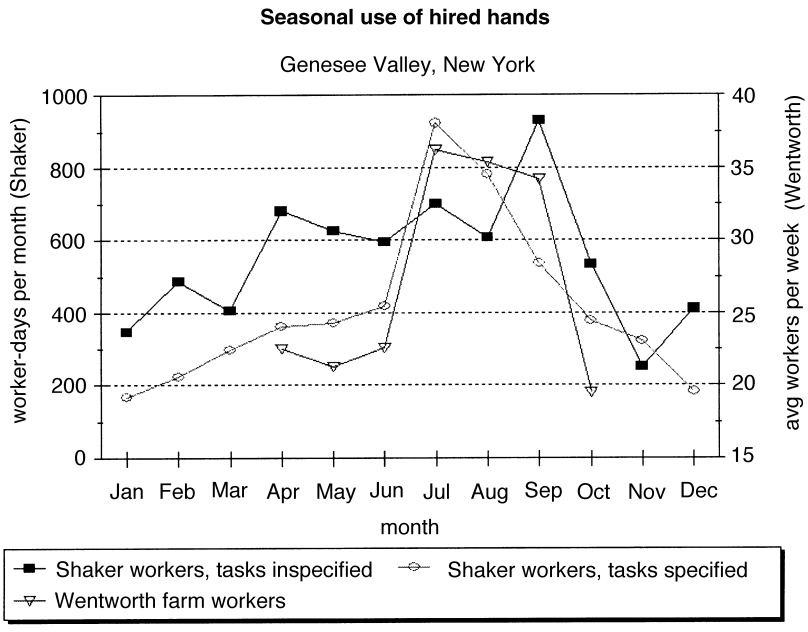

Fig. 2.

for unspecified work, although a few were for blacksmiths or teamsters. Seasonal distributions differed between the two locations as well, with two-fifths of Groveland's day workers, but only a quarter of New Lebanon's workers, having been hired in the summer. Since New Lebanon hired two-fifths of their workers in the spring, we can speculate that they were employed in preparing the fields for planting, but there is no way to know.

Hedonic daily wage regressions revealed regularities in greater detail than was possible with the monthly wage records (Table 5). Masons and millers at Groveland enjoyed substantial wage premia of about three-fourths over unskilled labor. Carpenters, joiners, and blacksmiths were paid about 45% more than unskilled labor. The premium paid to teamsters at Groveland was large as well, twice the payment for unspecified labor, but this sum included an implicit rental payment to the teamster for the use of his capital (the team of horses or oxen). At New Lebanon, work at a specific task, such as blacksmithing, for example, paid a significant premium of more than three-fifths over unskilled labor.

Table 5. Correlation Coefficients for Nominal Daily Wage Series.

Panel A: Unskilled Labor, 1800–1858		
	Shakers	Massachusetts
Massachusetts	0.15	
Vermont	0.67**	0.75**

Panel B: Skilled Labor, 1837–1858	
	Shakers
Massachusetts	0.39*

Sources of wage series:
Shakers: daily hired hands, Groveland, N. Y., 1837–1858.
Massachusetts: farm laborers, 1800–1855 (Rothenberg, 1992).
Vermont: farm laborers, 1800–1858 (Adams, 1944).
** = significance at 0.01 level.
* = significance at 0.10 level.

By season, both Groveland and New Lebanon paid a premium for help outside of winter. Comparing wage premia in Table 5 with the proportion of worker-days by season in Table 4 shows that for the most part seasonal premia corresponded to the seasons in which workers were most in demand. At Groveland the largest premium was paid in the summer, when more workers were hired than in any other season. At New Lebanon, the largest premium was paid in the summer, but more of their workers were hired in the spring than in the summer. At both communities, winter work paid the least, and that was when they hired the fewest workers.

Wage premia for skilled work were much larger in New York Shaker payments than were those found by Rothenberg in roughly contemporary Massachusetts farms. Part of the difference may have been due to the greater variety of tasks on the Shaker communes, as they operated not just farms but small manufacturing units as well. In fact, since there were few similar tasks in the Shaker and Massachusetts samples, it is not clear that these samples are in fact completely comparable. But it should be noted that there are similar tasks that reflect little similarity in wages. For example, Massachusetts farm hands working at haying and mowing were paid one-fifth more than those working on unspecified tasks; at Groveland haying paid one-sixth less than did unspecified labor.[22]

Significantly, the harvest premium was about the same in New York and Massachusetts. Rothenberg found that day laborers on Massachusetts farms around this time were paid a premium for harvest work in July and August,

the premium being due to the increased demand for hired labor that was relatively inelastic in supply around harvest time.[23] A subsample of Groveland wage payments was created using a methodology similar to that of Rothenberg. Consideration of farm related occupations only (excluding, e.g. carpenters and millers) in July and August yielded 157 observations, 67 of which were specifically for harvest work (including haying related tasks). Harvest wages were then compared to wages for the other tasks performed in July and August. The premium paid to the harvest workers of 27% (90.5 cents/day versus 71.4 cents/day) was very close to the 30% premium found in Massachusetts. The similar magnitudes of the farming-specific harvest premium in New York and Massachusetts suggests that the two labor markets shared important characteristics.

EXTENT OF AGRICULTURAL LABOR MARKETS

In general, significant wage premia by season and skill indicate Shaker awareness of prevailing market conditions, to which they responded in ways that enabled them to hire the quantity of labor that they desired. In that sense, wage premia that reflected greater productivity or seasonal demand indicate that the labor markets in which the Shakers participated were reasonably efficient. If, as it appears from wage data, the Shakers were participating in efficient markets for day and monthly laborers, it is natural to ask how extensive this market was. Economic theory proposes that a single market for a particular factor or product can be identified by the area within which the good sells for the same price, less transport costs. Holding such costs constant, it is generally easier to mark the path of integration by observing trends in prices over time rather than cross-sectional differences in absolute levels of prices. If several regions are in fact integrated into one market for a good, prices of that good, while possibly differing by region due to transport costs, should move together over time.

While antebellum commodity markets in the northeast have been shown to have been highly integrated, the state of integration among antebellum labor markets is not as clear.[24] Positively correlated prices (or wages) are a necessary condition for markets to be integrated, but they are not sufficient. If two or more segmented markets subject to the same shock, prices in those markets will correlate just as if they had been integrated markets. Thus, some evidence of actual labor mobility from region to region is needed to confirm the integration of northeastern labor markets. In fact, migration of farm labor in antebellum New York seems to have been quite common.[25] If labor was mobile, and the northeast formed a single market, then wages for labor in different parts of the northeast should be positively correlated with each other.

The Groveland daily wage data, combined with other farm wage samples from the antebellum northeast, provide an opportunity to test for correlation of northeastern farm worker wages over time. The Groveland data were divided into two subsamples, one for unspecified work or labor and the other for skilled labor, which can be defined conveniently as all the other, specified tasks. To minimize the effects of compositional changes, separate regressions were estimated using each subsample. Annual Shaker wage series were then formed as indices derived from coefficients of annual indicator variables, which thus prevented changes in skill or seasonal composition of the hired work force from affecting annual average wages.[26]

Two other series of wages for antebellum farm workers are available. Rothenberg's data consisted of day laborer wages recovered from account books of Massachusetts farms, which were separated into two series of higher and lower paying tasks. Component wages in the construction of these wage indexes were weighted to reflect different values added from different tasks. Adams's well known data on Vermont agriculture did not distinguish between skilled and unskilled wages for farm workers.[27]

Estimated correlation coefficients suggest that antebellum New York and New England may have formed one integrated market for farm labor.[28] Table 6 shows estimates of correlation coefficients that indicate a high degree of mutual correlation among the series of wages. Vermont farm wages were significantly and positively correlated with both Massachusetts unskilled farm wages and Shaker unskilled farm wages. Massachusetts and New York Shaker unskilled wages were positively but not significantly correlated. Wages for skilled workers among the New York Shakers and Massachusetts farms were positively and significantly correlated. It appears that Shaker wage setting over time was quite similar to that of farms elsewhere in the northeast.

Consider a possible cause of the wage patterns described above, which implies that conclusions reached here can be generalized to the world beyond Shakerdom. The Shakers did not offer wage premia to summer labor and to more skilled workers because they knew that Jesus had taught that "The laborer is worthy of his hire."[29] They did it because they knew that if they did not pay a worker according to his productivity, a competing employer would, and thereby hire away an important part of the Shakers' work force. It seems reasonable to suppose that, from the perspective of the laborers, there were many such employers where they would be found worthy of their hire. Those employers were the demand side and the laborers, skilled and unskilled, on long-term contracts and in spot markets by the day, formed the supply side of an efficiently functioning labor market.

Evidence that indicates the extent of a market economy for labor in the middle third of the nineteenth century addresses issues raised in historical writings about the nature of labor markets. Some historians of antebellum rural New York have suggested, implicitly or explicitly, that at some earlier time rural labor and products were exchanged according to custom and social obligation rather than market considerations. At some later point market considerations became paramount, marking the entry of the region into a "market revolution." Typically, the rise of market forces has been viewed dimly by these historians. For example, wage earners who worked on the Erie Canal have been described as victims of "an economic and social revolution," which exposed them to powerful, impersonal market forces, not usually for the better.[30]

Markets for agricultural labor crystallize many of the points stressed in recent histories of rural antebellum New York. Sheriff distinguished between unsystematic methods of compensation in canal work, and agricultural wage labor, in which workers stood in a "genuinely paternalistic relationship with their employers." This formulation would seem to question the possibility of systematic wage setting in agriculture, such as that suggested by the Shaker data. McMurry chronologically ordered the process of increasing market orientation, beginning with agricultural production and then proceeding to wage labor, a position in accord with Brooks' claim that "agrarian attitudes toward labor may have legitimized wage labor and industrial capitalism," both of which suggest that waged farm labor was a characteristic of the economy after the rise of markets. This transition to markets boded poorly for those who lived through it, as in their prior state of life they enjoyed a "dignity and worth" conferred by their relationship to the land. Participation in labor markets, on the other hand, made them "vulnerable to impersonal, wage-based, low-status employment," which was neatly summarized by the common use of the word *degraded* to describe laborers' work for pay.[31]

One sign of a moral economy as emphasized in these histories is a lack of cash. Would-be market participants resorted to barter or credit exchanges, which were subject to cultural rather than economic forces. Sheriff even indicates that traders *preferred* not to use cash "because they saw no use for assigning monetary values." In some circumstances, the issue of cash and credit is of great importance: Brooks found landowners in western New York eager to force their tenants into debt peonage whereby the tenants' first priority would have been to produce for market in order to gain cash for rental payments.

In regard to labor such distinctions between cash and non-cash exchanges seem specious. In the present study, for example, there is no way to know with certainty whether the Shakers paid their laborers with cash. The manuscript evidence suggests that cash payments were rarely made; rather, the Shakers

kept running accounts with each of their men, tallying work on the debit side and issuance of clothing, tools, or other household items as credits for which the Society was owed. Thus, payments to workers in kind or in credit were done through implicit wages. A priori such non-cash wages can bear all of the information on scarcity that would be carried by wage rates that were realized through cash exchanges for labor.[32]

And in fact, wages paid by the Shakers through such "book credit" reflected the supply of labor and the Shakers' demand for their services. The wage record of just two farms is a limited amount of data, and the period covered in this study extended back only to the later first quarter of the nineteenth century. Still, some conclusions presented here can be generalized to areas beyond these two, large farms. Shaker communalists, who were committed to isolation from a fallen world and who seem not to have used cash in paying their workers, followed market forces in setting wages in the middle third of the nineteenth century. Wages that reflected supply and demand, and that were similar to those in neighboring states, suggest that agricultural labor markets in mid-nineteenth century New York appeared not *ex nihilo* following a market revolution, but were the gradual elaboration of long established practices.

NOTES

1. In fact, the dozen or so Shakers who live at the Sabbathday Lake, Maine, community still are Christian communalists, but since it is the historical Shakers that concern this paper, the past tense will be used.

2. Manuscript *Shaker Record B*, p. 66, Shaker Collection of the Kentucky Library, Western Kentucky University.

3. Isaac Newton Youngs, *Concise View of the Church of God . . .* (1856). Manuscript no. 861, Edward Deming Andrews Memorial Shaker Collection, Winterthur Museum and Library, Winterthur, Delaware, p. 502; Stephen J. Stein, *The Shaker Experience in America: A History of the United Society of Believers* (New Haven: Yale University Press, 1992), pp. 298, 308.

4. Charles Nordhoff, *The Communistic Societies of the United States from Personal Observations* (New York: Dover Publications, 1966 reprint), pp. 162, 182, 256.

5. Wage records of hired workers can be found in the following sources. For Groveland, see Western Reserve Historical Society Shaker Collection manuscripts II:B-11, II:B-12, II:B-15, II:B-16, and II:B-27. For New Lebanon, see Edward Deming Andrews Memorial Shaker Collection, Winterthur Museum and Library, items numbered 1103, 1108, 1114, 1115, 1116, 1130, 1137, 1152.

6. Winifred B. Rothenberg, *From Market-Places to a Market Economy: The Transformation of Rural Massachusetts, 1750–1850* (Chicago: University of Chicago Press, 1992), pp. 181ff.

7. Nor, in personal communications, could Herbert Wisbey, emeritus professor of history at Elmira College and historian of the Groveland Shakers.

8. Stein, *Shaker Experience*, p. 200.

9. Stein, *Shaker Experience*, p. 200, associates hired labor with communal decline, as do *Andrews and Andrews*, Work and Worship, p. 209.

10. Stein, *Shaker Experience*, p. 380ff.

11. Joseph C. G. Kennedy, *Population of the United States in 1860* (Washington: Government Printing Office, 1864).

12. Rothenberg, *From Market-Places to a Market Economy,* p. 187. Rothenberg also uses the term *contract* to describe the duration of employment.

13. Payments to Groveland workers appear to have consisted of cash and board, as was typical in the market for monthly labor. One worker who lived nearby was paid 14/ extra for three weeks since he did not board with the Shakers (July 1847, WRHS II:B-15). The implied value of boarding, $0.58 per week, is a good bit less than Bidwell and Falconer's estimate (Percy Wells Bidwell and John I. Falconer, *History of Agriculture in the Northern United States 1620–1860* (Washington, D.C.: Carnegie Institution, 1925, p. 275), of $1.25 for New York in 1849. In the same volume, however, this man was later reimbursed at a rate of 2/ per day, which yields a weekly equivalent of $1.50, much closer to Bidwell and Falconer.

14. Stanley Lebergott, *Manpower in Economic Growth* (New York: McGraw-Hill, 1964); Neil A. McNall, *An Agricultural History of the Genesee Valley* (Philadelphia: University of Pennsylvania Press, 1952), p. 88; Bidwell and Falconer, *History of Agriculture*, p. 275.

15. McNall, *Agricultural History*, pp. 88, 228–229; Charles E. Brooks, *Frontier Settlement and Market Revolution: The Holland Land Purchase* (Ithaca: Cornell University Press, 1996), pp. 129, 141; Stein, *Shaker Experience*; Herbert Wisbey, *The Sodus Shaker Community* (Lyons, N.Y.: Wayne County Historical Society, 1987).

16. Robert A. Margo and Georgia C. Villaflor, "The Growth of Wages in Antebellum America: New Evidence," *Journal of Economic History*, *47* (1987), pp. 873–895; for a contemporary European example of literacy and greater agricultural productivity, see Lars Pettersson, "Reading and Writing Skills and the Agrarian Revolution: Scanian Peasants During the Age of Enclosure," *Scandinavian Economic History Review*, *44* (1996), pp. 207–221.

17. Manuscript schedules, U.S. Censuses of Population and Agriculture, Livingston County, New York, 1860.

18. By comparison, Rothenberg, *From Market Places*, used 3018 observations covering a period of about a century, while Margo and Villaflor, "Growth of Wages," had 3555 observations in the Northeast alone for a period of 36 years. Thus, Rothenberg's sample yielded about 30 observations per year, Margo and Villaflor's about 100 per year, and the Groveland sample also about 100 per year.

19. Bidwell and Falconer, *History*, p. 204.

20. My guess is that "work in storm" refers to getting the hired men to milk cows in bad weather. Although Shaker women typically milked dairy cattle, Shaker men would milk in storms. See John E. Murray and Metin M. Coşgel, "Between God and Market: Influences of Economy and Spirit on Shaker Communal Dairying, 1830–1875," *Social Science History*, *23*, pp. 41–65 (spring 1999).

21. McNall, *Agricultural History*, p. 112.

22. Rothenberg, *From Market Places*, pp. 161–163.

23. Rothenberg, *From Market Places*, p. 198.

24. Rothenberg, *From Market Places*, pp. 108–111.

25. Donald Parkerson, *The Agricultural Transition in New York State: Markets and Migration in Mid-Nineteenth Century America* (Ames: Iowa State University Press, 1995), pp. 137–141.

26. Since a reasonable degree of product market integration in the Northeast over this period has been established in Rothenberg, *From Market-Places*, the difficulties of creating a Shaker specific price series with which to deflate the Shaker wage series can be circumvented by considering nominal wages for all available labor markets.

27. Rothenberg, *From Market Places*; Thurston M. Adams, *Prices Paid by Vermont Farmers for Goods and Services and Received by Them for Farm Products, 1790–1940*. (Burlington, VT: Vermont Agricultural Experiment Station Bulletin 507, 1944).

28. Sophisticated statistical models exist for the testing of market integration with price data. Bob Baulch, "Testing for Food Market Integration Revisited," *Journal of Development Studies*, *33* (1997), pp. 512–534, indicates that no one of the following is superior to the others: the Law of One Price, the Ravallion Model (useful for a market with a well defined center region), cointegration tests, and Granger causality tests. Given the mixture of weighted means and regression coefficients, and agricultural and non-agricultural tasks that characterize the available wage samples, the conservative course seemed to be the presentation of simple correlation coefficients, and significance levels thereof.

29. *Gospel According to St. Luke*, chapter 10, verse 7, King James translation.

30. Carol Sheriff, *The Artificial River: The Erie Canal and the Paradox of Progress, 1817–1862* (New York: Hill & Wang, 1996), p. 167.

31. Sheriff, *Artificial River*, pp. 40, 42, 45, 155; Sally McMurry, *Transforming Rural Life: Dairying Families and Agricultural Change, 1820–1885*. (Baltimore: Johns Hopkins University Press, 1995), pp. 45, 70; Brooks, *Frontier Settlement*, pp. 11, 129.

32. Sheriff, *Artificial River*, pp. 11, 110; Parkerson, *Agricultural Transition*, pp. 63–64; Brooks, *Frontier Settlement*, pp. 113, 125; McMurry, *Transforming*, p. 55; on 57 she dates the transition to cash exchanges as having occurred in the 1850s.

ACKNOWLEDGMENTS

I am grateful for the comments of many scholars on previous drafts but especially Metin Coşgel, David Galenson, Joyce Jacobsen, Bob Margo, Mark Ramseyer, Joshua Rosenbloom, Rick Steckel, Werner Troesken, Sam Williamson, and seminar participants at Chicago, Bowling Green, the 1998 Clio/AEA sessions, and the 1998 NBER-DAE Summer Institute. Mingshu Jin provided excellent research assistance. A B. R. Robinson Fellowship from the Winterthur Museum and Library allowed for collection of some of the data analyzed here.