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7 The Productivity Consequences of Market Integration: Agriculture in Massachusetts, 1771–1801

Winifred B. Rothenberg

Two decades ago, Peter Temin proposed with a simple two-sector model to expose the logical fallacy in the labor-scarcity thesis.[1] If land is "free," he wrote, then "farmers will find themselves with more land than before, which they will use to produce agricultural products. As their workers will have more land to work, their productivity will rise. If their wages do not rise, it will pay the farmers to hire more workers. If their wages do rise, more workers will be attracted to agriculture. These new agricultural workers will come from the only other sector of the economy: manufacturing" (Temin 1971, 255 n. 5). But if land is "free," then capital—no less than labor—will also be attracted to agriculture where its productivity is enhanced by the abundance of complementary resources. Thus, free land in American agriculture "explains" capital scarcity as well as it "explains" labor scarcity, and therefore cannot motivate the capital-using bias in American manufacturing.

Implicit in Temin's argument was the assumption that the agricultural and manufacturing sectors are sufficiently alike to be treated alike, that labor and capital will shift between sectors in either direction. Useful as this model was for Temin's purpose, it ignored the central paradox of agriculture, and by ignoring it, alerts us: in the development process resources do not flow symmetrically between sectors; they do not flow into agriculture in response to the rising labor productivity achieved there. The response of a developing econ-

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1. The labor-scarcity thesis holds that the preference for labor-saving machinery in American manufacturing "was fundamentally because the remuneration of American industrial labour was measured by the rewards and advantages of independent agriculture" (Habakkuk 1962, 11).

omy to rising productivity in agriculture—and uniquely in agriculture—is an *exodus* of resources from it. It is the paradox of the development process—but no less true for being a paradox—that while rising productivity in agriculture has been (and with the exception of oil- and mineral-rich countries still remains) the key to successful economic development, its function is to make possible the sector's declining output share.[2] Only growing productivity in agriculture can release the resources invested in it to still more productive sectors whose growth relative to agriculture is what we mean by economic development. And only growing productivity within agriculture can prevent the deleterious health and standard-of-living consequences of its sectoral decline.[3]

The sectoral decline of agriculture in the development process is necessary because, alone among the producing sectors in a market economy, the products of agriculture face implacable price and income inelasticities of demand. Expanded agricultural output, whatever its source, causes farm prices to fall disproportionately, and the earnings of farmers to lag further and further behind the growth of output and earnings in the rest of the economy. But should agricultural prices remain high because of a failure to achieve the very productivity growth that dooms it to falling prices, the short-run advantage the sector would experience in its terms of trade would lower real incomes and impede real growth in the rest of the economy. It is the combination of productivity growth, remorselessly low price and income elasticities of demand, falling prices, worsening terms of trade, and no-better-than-constant returns to scale that drives resources out of agriculture—a sector that grows, in effect, by feeding on its own tail![4]

That process in less developed countries today is driven, for better or worse, by deliberate government policy in the areas of commodity pricing, manpower training, relocation, housing, tariffs and trade, taxation, and subsidization; but in Massachusetts in the late eighteenth century the arbiter of that complex process was the market (Rothenberg 1981). It was the market economy that energized the farm sector to achieve labor's first productivity gains (Rothenberg 1988). It was the market economy that presided over the shift of resources into the nation's first industrial sector (Rothenberg 1985).

The process of initiating the transformation, of "getting agriculture mov-

2. Three-quarters of the twenty-three countries that in the 1970s experienced GDP growth of over 5 percent per annum had achieved growth rates in their agricultural sectors of over 3 percent per annum. With the exception of the oil-rich and mineral-based economies, no more than 2 percentage points separated the rates of agricultural and GDP growth in the successfully developing countries in the 1970s (World Bank 1982, 44–45, cited in Timmer 1988, 1: 277).

3. The quantity and quality of nutrients (especially proteins) in the diet is being discovered to be a good predictor of height, of life expectancy at age ten, of the capacity to work hard and protractedly, of resistance to epidemic diseases. Maternal nutrition also plays a major role in the birth weight and health of their infants (Fogel 1990; and Goldin and Margo 1989, especially 370–77).

4. I owe these very useful insights to C. Peter Timmer (1988, 276–331).

ing,"[5] of kicking the system off its suboptimal equilibrium, is not easy to observe, but once it does begin, the "Smithian" process that relates the extent of the market to the division of labor generates a feedback process that intensifies the use of inputs, increases output, expands markets, and—most relevant of all in premechanized agriculture—enhances what Moses Abramovitz has called "the effectiveness of labor hours" (Abramovitz 1989, 15). The total factor productivity growth[6] this feedback process made possible may well have "got agriculture moving" in Massachusetts. But how did it *begin?*

The trigger may well have been a shift in relative prices: in the late 1770s, crop prices, buoyed by wartime demand and inflation, rose more rapidly than farm wages for the first time in nearly three decades (figure 7.1).[7] Perhaps in this environment of rising prices for their products and falling "real" wages, farmers could afford to increase their use of underemployed labor services, "calling forth and enlisting for development purposes resources and abilities that [had lain] hidden, scattered or badly utilized" (Hirschman 1986, 56). They could afford to; the question is, did they? Did Massachusetts farmers respond to these market signals, and if so, how and when?

The motive and the cue for growth are first to be discovered in evidence that market outcomes informed the decisions respecting land use, output pricing, employment, the investment of rural savings, livestock holdings, and crop mix made individually by the approximately 50,000 farm households in Massachusetts in the late eighteenth century.[8] Thereafter one looks to find a way to measure the productivity consequences of that market penetration. I have been attempting for many years to do that, finding in microlevel sources—farm account books, daybooks, and probates—evidence that the end of the

5. "Getting agriculture moving" is a phrase that Timmer adopts from a book of that title by A. T. Mosher, with the subtitle "Essentials of Development and Modernization" (New York: Praeger, 1966).

6. The growth rate of output can be "decomposed into a portion contributed by 'total factor input,' which was the joint contribution of labor and capital (including land), and a portion contributed by 'total factor productivity.' The first was the sum of the growth rates of the factor inputs, each weighted by the share of its earnings in national income. The second was the difference between the growth rate of output and that of total factor input" (Abramovitz 1989, 14).

Depending on how this second "residual" portion is measured, it can be made to account for 99 percent, 70 percent, or 51 percent of the growth of output per worker; or for 36 percent (Edward Denison's estimates for the United States, 1948–79), or 24 percent of the growth of total output (Dale Jorgenson's estimates) (Abramovitz 1989, 15–19).

7. I say "inflation," not "hyperinflation." The hyperinflation during the Revolutionary War was a currency phenomenon in which prices skyrocketed in terms of the overissued and wildly depreciating paper Continental. But farm accounts, being repositories of long-term debt, were kept not in Continentals, but in Lawful Money or Old Tenor—the latter a paper currency recalled as a medium of exchange in 1750 but used by many farmers long thereafter as a unit of account. Account-book prices and wages were never hyperinflated.

8. I arrive at this estimate of 50,000 as follows: the surviving records of 38,000 rateable polls (nonexempt males age 16 and over) in 1771 are estimated by Bettye Hobbs Pruitt, editor of the 1771 tax valuation list, to constitute two-thirds of the taxable adult males, of which approximately 90 percent were "engaged in agriculture." I am deeply indebted to Dr. Pruitt for sharing with me the data for her pioneering analysis of the 1771 valuation list.

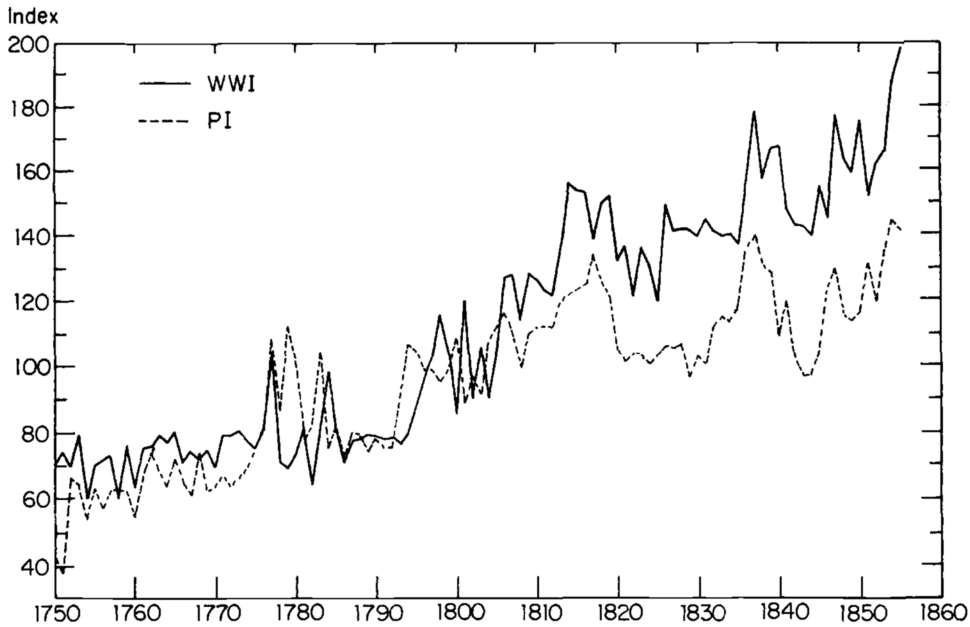

Fig. 7.1 Weighted wage index and price index, 1750–1855 (1795–1805 = 100)
Notes: WWI = Rothenberg weighted wage index of crop-related tasks; *PI* = Rothenberg farm commodity price index.
Source: Farmers' account books. The price index appears in Rothenberg (1979, 983–85). The wage index appears in Rothenberg (1988, figure 2, appendix 3).

Revolutionary War ushered in a period of profound economic transformation in the rural economy of Massachusetts. Expanding market orientation has not only been documented from the behavior of the relevant prices, but was found to have been linked to an upturn in the time trend of labor productivity as measured—not directly (by, say, output per man-day) because data of that kind for our period are lacking, but indirectly, by means of the dual, the ratio of a Massachusetts farm wage index to a Massachusetts farm commodity price index, which measures the real cost of labor to employing farmers (see figure 7.2).[9]

But the inquiry should not be left there. For one thing, it matters to the

9. "Movements of real wages—defining real wages as money wage rates divided by a cost-of-living index—are not, of course an appropriate indicator of the trend in the marginal physical productivity of labor employed in a particular sector or industry. What is relevant, assuming competitive or consistently imperfect product and labor market conditions, is the real cost of labor to employers in the industry under consideration; real wages received by farm workers could change merely as a result of changes in the farmer-employers' terms of trade with the rest of the economy, without any alteration in marginal labor productivity having taken place. Thus, for the present purpose, the relevant wage-deflator is an index of the prices received by farmers for those commodities in whose production hired labor was used" (David 1967, 179–80).

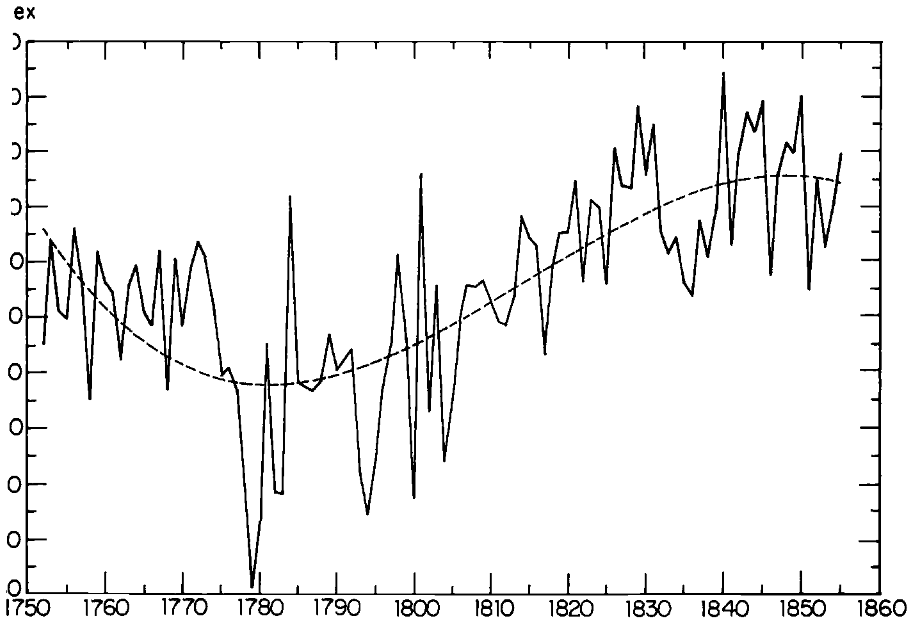

Fig. 7.2 Tracing the growth of agricultural labor productivity: the real cost-of-labor index, 1752–1855

Notes: The years 1750 and 1751 were omitted as outliers. The dotted line is the plot of the equation regressing the ratio of my weighted wage index to my price index on time.
Source: Farmers' account books. The indexes, regression equation, and plot appear in Rothenberg (1988, appendix 3, table 3, figure 4).

interpretation of the "real cost of labor index" whether its rise after 1785 is due to the rise of the productivity wage in the numerator, or to a decline of the commodity price index in the denominator. Even in highly evolved markets, structural changes—for example, lower transport costs—may have asymmetrical effects (at least in the short run): a significant impact upon farm prices but little if any on farm wages. This would compromise our interpretation of movements in the ratio between them. But even more to the point, the question—the timing of the productivity upturn in preindustrial Massachusetts—is of such critical importance to estimates of the pace of early American economic growth that it should not be left to hang on the dual. If it really happened, if Massachusetts farmers—presumably for the first time—experienced increasing output per worker, that fact should show up in other behavioral correlates.

In this paper I experiment with the use of data aggregated to the town level to confirm the turning point observed in figure 7.2, and to make more robust the case for the onset of productivity growth in Massachusetts agriculture before 1800. On the basis of town tax valuations for the years 1771, 1786, 1792, and 1801,[10] I advance the following propositions. (1) A significant improvement in Massachusetts agriculture can be confirmed from expanded output, diversification of crop mix, shift in land use, improved per acre yields, and increased emphasis on animal husbandry, all by 1800. (2) Growth in this agriculture was accompanied by the intersectoral shift of capital into commerce, banking, and infrastructure investments as required by the development process. (3) Widening differentials in rates of productivity growth exacerbate income inequalities within the rural economy, with serious political consequences. The 1786 tax valuations allow us to understand Shays's Rebellion in these terms.

The case for increased output and improved yields is made in table 7.1, where aggregate magnitudes are compared across tax valuations from 1771 to 1801. It should be acknowledged at the outset that intertemporal comparisons of tax lists are as problematic as intercensal comparisons. Much of the 1771 list has not survived, and part of what has survived is illegible. Many of the categories of taxable wealth are incommensurable across time: in 1786, no outputs (except cider) were taxed and consequently none (except cider) were enumerated; sheep and goats were counted in 1771, counted but not taxed in 1786, and not counted in 1792 and 1801, so that total livestock holdings cannot be compared across time; the age at which animals became taxable (and therefore enumerated), and the categories into which they were grouped, changed from valuation to valuation; and differences between valuations respecting the month in which property was assessed will much affect the number of animals found on the farms (Garrison 1987, 5). "Dooming"—that is, underreporting, tax evasion, and the systematic downgrading of land quality—although heavily penalized at the time, was extensive, particularly in the valuation for 1786, a depression year. The ubiquity of out-pasturing from valley farms to hill towns renders town pasture acreage an understatement and therefore overstates its "efficiency." The reconfigured map of Massachusetts—town boundaries redrawn, lands annexed, new counties carved out of old, new towns "hived off" from old—makes intertemporal comparisons of town outputs, town acreages, and therefore town yields, hazardous.[11] Nevertheless, the finding in table 7.1 that there was considerable improvement in all the magnitudes by 1801 appears robust enough to withstand problems in the data.

The output of grains by 1801 was nearly two and a half times what it had been only thirty years before. Corn was by far the principal grain, accounting for more than 50 percent of grain output.[12] "Rye-n-injun"—corn mixed with

10. The data are available on request from the author.

11. Indeed, it is just because working with these valuations is so perilous that data sets built from farm account books and probate inventories are so valuable.

12. Wheat, by contrast, accounted for only 4 percent. Black stem rust, a fungus, parasitic in one of its stages on the barberry bush, had appeared in 1660 and had virtually eliminated wheat cultivation in Massachusetts except in the western county of Berkshire, where it made up 20 percent of grain output.

Table 7.1 Improvements in Agriculture, 1771–1801

	Date of Tax Valuation			1771–1801,
	1771	1792	1801	% Change
No. of towns[a]	122	239	263	
Polls, rateable + unrateable[b]	34,648	79,949	87,842	+154
Tillage (acres)	99,280	191,802	208,822	+110
Combined grains (bushels)[c]	1,044,588	2,432,802	2,505,338	+140
Bushels of grain per acre tillage	10.5	12.7	12.0	+14
English/upland mowing (acres)	94,121	195,429	257,214	+173
English/upland hay (tons)	65,148	139,707	190,412	+192
No. of grazing animals	98,216	219,167	251,165	+156
Tons English hay per grazing animal	0.66	0.64	0.76	+15
Tons English hay per acre mowing	0.69	0.71	0.74	+7
Fresh meadow plus salt marsh (acres)	99,445	169,899	220,657	+122
Fresh meadow (acres)	82,896	140,609	190,149	+129
Salt marsh (acres)	16,534	29,190	30,508	+85
Fresh plus salt hay (tons)	53,168	147,279	167,531	+215
Tons fresh/salt hay per grazing animal	0.54	0.67	0.67	+24
Tons fresh/salt hay per acre meadow	0.53	0.87	0.76	+43
Pasture (acres)	200,934	568,534	751,128	+274
No. of cows pasture will "keep"	76,174	275,862	236,700	+211
No. of cows one acre pasture can keep	0.38	0.49	0.32	−17
No. of neat cattle[d]	81,473	185,820	205,140	+152
No. of horses	16,743	33,447	46,025	+175
No. of swine	46,176	80,248	84,949	+84
No. of sheep and goats	115,079	N.A.	N.A.	—
No. of total livestock[e]	144,392	299,515	336,114	+133

Sources: Town Tax Valuation Lists, 1771, 1801, Massachusetts State Archives; Felt 1847 for 1792 data.

[a]In addition to the 1771 town valuations that did not survive or are illegible, the towns in Maine, Cape Cod, Nantucket, and Martha's Vineyard are omitted from this table, as they are from this study as a whole.

[b]Includes taxable males sixteen to twenty-one years of age, taxable males twenty-one years of age and upward, male polls exempt from tax but not supported by the town (governor and lieutenant governor of Massachusetts, settled ministers, grammar school masters, and officers, faculty, students at Harvard), male polls exempt because supported by the town (paupers). Population is conventionally estimated by multiplying the number of polls by four. "Computing the polls in the ratio of 4½ [is] larger than usual" (Felt 1847, 165).

[c]The grains are wheat, rye, oats, corn, and barley.

[d]*Neat,* from an Anglo-Saxon root meaning "to use," includes oxen, cows, steers, and bulls. However, several of the valuations distinguish between oxen, cows, and neat cattle. In this table it is used to mean all bovine animals.

[e]Because the valuations of 1792 and 1801 did not count sheep and goats, I have, for the sake of comparability, omitted them from this total in 1771. In 1786, sheep and goats were enumerated but were not taxed.

rye—was the staple bread of farm family consumption, but as much as 60 percent of the corn output in 1800, by my estimate, was used as feed to fatten swine and as a supplement for cows in milk.[13]

While grain yields rose over 20 percent between 1771 and 1792, it will be observed in table 7.1 that they then fell back about 5 percent between 1792 and 1801. That drop in grain yields in the 1790s may testify to the depletion and predatory "mining" of the soil that foreign observers and agricultural reformers were fond of deploring. But less grain per acre of tillage may testify also to a diversification of output away from grains. By the turn of the nineteenth century, Massachusetts farmers had found many noncereal crops to grow on their tilled lands: potatoes, hops, flax, green herbs, celery, rutabaga, beets, winter squashes, pumpkins, carrots, parsnips, turnips, cabbages, onions, tomatoes, asparagus, string beans, green peas; and peaches, pears, rhubarb, new kinds of apples, strawberries, cherries, damson plums, quinces, cranberries, and wine grapes (McMahon 1985). Broomcorn (for brooms) and tobacco (for cigar wrappers) became the major agricultural exports of the Connecticut River valley.[14] Because none of these outputs (with the exception of peas and beans) is enumerated in the tax valuations for the period, their quantitative importance remains in doubt, but in view of this diversification away from grains it would be an error to make the case for declining *crop* yields on the basis of declining *grain* yields.

The improvement between 1771 and 1801 in aggregate grain output in table 7.1 should not be allowed to obscure the high variance among towns in both outputs and yields. While aggregate grain *output* expanded 140 percent, the experiences of individual towns varied between a more than fivefold increase in Blandford and a more than 50 percent decrease in Springfield. And while grain *yields* statewide increased 14 percent between 1771 and 1801, there were fifty towns where they increased far more than that—in four of them yields more than doubled—but thirty-three towns where they actually fell, in one case to nearly half the 1771 level. Some of that heterogeneity is caught in the differences between county-level yields in table 7.2.

Differential proximity to urban places, to waterways, to turnpikes—in short, to western competition—may account for the differential pace of diversification away from grains. It is likely, by increasing the variance, to have

13. My estimate of the proportion of corn used up for seed, to fatten swine, and as feed for cows in milk is discussed in Rothenberg (1979, 989–90).

14. As early as September 1738, Rev. Ebenezer Parkman, of Westborough, Massachusetts, noted in his diary a shipment of five hundred hogsheads of tobacco being sent down the Connecticut River to the West Indies. By 1860, Massachusetts farmers were growing 3.2 million pounds a year, chiefly for the New York market (Clark 1990, 294–303). Tobacco, having become important to the region when the broomcorn bonanza petered out, soon replaced it as the major agricultural staple of the antebellum period.

"The growing of broom corn dated from about the year 1800. In 1825 it had become a staple in the river towns; in the town of Hadley alone 1,000 acres were annually planted . . . . 'The mode of culture, in the towns on Connecticut river, is very similar to that of Indian corn, but it is said to require two or three times as much labour' " (Bidwell and Falconer 1925, 245).

Table 7.2 **Yields**

County	Date	Bushels of Grains per Acre Tillage	Tons of English Hay per Acre Mowing	Tons of Fresh/Salt Hay per Acre Meadow/Marsh	Cows Supportable per Acre Pasture
All towns	1771	11.8(3.9)	0.7	0.9	0.38
	1801	13.4(4.0)	0.8(0.4)	0.8	0.30
Suffolk/Norfolk	1771	14.5(2.7)	0.5	0.8	0.33
	1801	14.4(3.2)	0.5(0.1)	0.7	0.28
Essex	1771	14.7(2.6)	0.7	1.0	0.28
	1801	16.6(3.5)	0.9(1.3)	0.8	0.23
Middlesex	1771	13.7(3.5)	0.6	0.8	0.38
	1801	13.6(3.6)	0.7(0.1)	0.7	0.28
Hampshire	1771	7.7(2.3)	0.9	1.0	0.59
	1801	11.1(3.9)	1.0(0.2)	0.8	0.43
Plymouth	1771	11.0(2.6)	N.A.	N.A.	0.34
	1801	11.6(2.0)	0.6(0.1)	0.8	0.21
Bristol	1771	10.0(1.6)	0.6	0.8	0.31
	1801	11.1(2.1)	0.5(0.1)	0.7	0.24
Worcester	1771	14.1(2.4)	0.8	1.1	0.18
	1801	16.7(2.8)	0.8(0.1)	0.8	0.30
Berkshire	1771	8.4(1.6)	0.6	0.3	0.45
	1801	10.7(3.0)	0.9(0.1)	0.8	0.42

Source: Town Tax Valuation Lists, 1771, 1801, Massachusetts State Archives.

Note: The 1771 valuations are disaggregated by name of poll. Town totals for 1771 come from summing page totals where given in the original list, and, where those are missing, the totals are taken from the calculations made by Bettye Hobbs Pruitt for her compilation of the original data. She did not, however, calculate yields for English hay, salt hay, and meadow hay separately, but rather summed all three. The hay yields shown in this table are based on the towns for which there were totals in the original document. Because only five Plymouth County town valuations survive from 1771, there were too few English and meadow hay totals to enter. Standard deviations are in parentheses.

moderated the overall improvement of grain agriculture.[15] But more important than new tillage crops in the transformation of Massachusetts agriculture was the shift from tillage crops to grasses. Massachusetts farmers were moving away from cereals to specialize in hay, and this restructuring was happening in advance of significant western competition: long before through-rail service between Boston and the Midwest (1853), long before competition from the Cincinnati hog markets (1840s), and even long before the Erie Canal (1825). In fact, the shift, visible in table 7.1, from grains to grasses, and between grasses from the natural to the cultivated, can be observed in the act of happening, as it were, by 1801. While tillage acreage increased 110 percent over the period and fresh-meadow and salt-marsh[16] acreage (both natural grasses)

15. The reader will notice from table 7.1, for example, that the increase in grain output did not quite keep up with the increase in population (estimated as four times the number of polls).

16. Salt marsh hay, with phenomenal yields cited of up to ten tons per acre (more probably, two tons per acre), is the salt-tolerant grass that grows in coastal wetlands wherever a tidal rise and fall

increased 122 percent, the acreage in cultivated grasses (English and upland mowing) expanded by 173 percent. And English hay, which accounted for 46 percent of total hay tonnage in 1771, accounted for 53 percent thirty years later.

Hay was always of great significance to the New England economy in three respects: as primary input in the production of dairy products, meat, hides, urban livery services, and manure; as primary input in the production of livestock; and as a locally traded output protected from distant competition by its bulk and low value relative to bulk. But the grasses native to New England offered such poor nutrition that they constrained the expansion of the animal stock, and—as the principal constituent of manure—failed to enrich the soil. The most outstanding agricultural reform between 1750 and 1800 in the northern colonies was the diffusion of English grasses, which were probably brought to this shore accidentally, "the seeds buried in the fodder and bedding shipped across the Atlantic with the colonists' cherished livestock" (Stilgoe 1982, 183). The English grass—called "herdsgrass" in New England after John Herds, and "timothy" in New York, Maryland, and the Piedmont after Timothy Hansen—was mixed with redtop and clover and broadcast on upland meadows (called "mowing"), which careful farmers kept plowed and dressed with manure. In farm account books English hay was always twice as valuable as native hay[17]—selling for $10 a ton when fresh meadow hay sold for $5—and it diffused so rapidly that acreage in English and upland mowing came close to tripling in Massachusetts in the thirty years between 1771 and 1801. "Long after the first frost turned the native grasses brown . . . the English grasses remained true to their old climate and stayed green, providing pasturage into December . . . . [E]verywhere man shaped[,] the land was green and everywhere he left it untouched it was brown. Herd's grass or timothy announced the coming of civilization, of shaped land" (Stilgoe 1982, 184).

If the specialization in cultivated grasses was in fact occurring among the generality of Massachusetts farmers, we should see it in a shifting pattern of land use: a retreat from tillage and fresh meadow in favor of an increasing proportion of farm acreage devoted to mowing.[18] From the valuations of 1786 and 1801, table 7.3 aggregates to the county level the town data on land use

occurs. The fact that acreage in salt marsh was always taxed at a higher rate than fresh meadow suggests that it produces more hay, or perhaps a more valuable hay, although I have been unable to discover its nutritional properties. Animals grazing in the marshes or drawing the hay out were fitted with large flat "bog shoes." The hay was thrown onto "staddles" to dry and brought in when the marsh iced over in the winter (Smith et al. 1989).

17. According to Stilgoe, so valuable was the English hay that farmers put their fresh meadow hay in the barn and kept the stacks of English hay out in the meadow where they would be protected from barn fires lit by lightning (Stilgoe 1982, 184).

18. Changes in land use are measured in terms of *proportion* of acreage, not acreage itself, because of the constant redrawing of town boundaries and establishing of new towns from parts of the old that characterized this period. Between the valuations of 1786 and 1801, 116 towns gained or lost land, and some did both.

Table 7.3 **Acreage by Land Use as a Proportion of Total Acres**

County	Date	Tillage	Mowing	Meadow & Marsh	Pasture	Woodlands
All towns	1786	.06	.06	.06	.18	.53
	1801	.06	.08	.06	.22	.46
Hampshire	1786	.05	.03	.03	.05	.70
	1801	.07	.06	.04	.12	.57
Worcester	1786	.04	.05	.06	.13	.61
	1801	.04	.06	.07	.22	.51
Berkshire	1786	.08	.07	.01	.11	.58
	1801	.07	.07	.02	.15	.47
Suffolk/Norfolk	1786	.05	.10	.11	.32	.34
	1801	.05	.11	.09	.29	.35
Essex	1786	.09	.11	.11	.45	.18
	1801	.08	.11	.11	.44	.20
Middlesex	1786	.07	.07	.10	.21	.47
	1801	.07	.09	.09	.28	.42
Plymouth	1786	.06	.04	.06	.19	.48
	1801	.05	.06	.06	.19	.51
Bristol	1786	.08	.08	.06	.20	.50
	1801	.05	.09	.05	.21	.48

Source: Calculated from Town Tax Valuation Lists, 1786, 1801, Massachusetts State Archives.
Note: The rows do not sum to one hundred because of the omission of "unimproveable" acreage from this table.

as a proportion of *total* acreage.[19] Tillage and fresh meadow decreased as a percent of *improved* acreage in all counties, and mowing increased as a percent of *total*.

That the shift in the crop mix and land use from grains to hay, from tillage to grasslands, and from fresh meadows to upland mowing was a shift in the direction of higher-valued uses of land is confirmed in a comparison of differential tax rates on the several forms of taxable property (see table 7.4).[20]

19. Aggregating to the county level is not only a compact way to handle this large data set, but also makes good economic sense. In many respects the counties are more different from one another than are the towns within them, suggesting that they are good proxies for regions. Counties differed markedly in the proportions of wheat, rye, corn, oats, and barley in their grain output; in indexes of commercialization; and, of course, in the presence salt marsh.

The valuation of 1771 had to be omitted from table 7.3 because it did not count "woodland and unimproved" or "unimproveable" acres. "Unimproved" and "unimproveable" acres were counted in both 1786 and 1801. In table 7.3 I have not included "unimproveable" lands—much of which is land under water—in the total acres, and hence the rows do not sum to 100 percent. Thus, in table 7.3 "total" = tillage + English and upland mowing + fresh meadow + salt marsh + pasture + woodland and unimproved.

20. The valuation of 1771 had to be omitted from table 7.4 because it contains no tax rates.

The absolute level of tax rates bears no obvious relation to land values, but their levels relative to one another are suggestive. According to Harold Hitchings Burbank, the procedure for determining how the state direct tax should be apportioned among the towns was first to calculate the poll tax at one penny or ha'penny (1*d* or ½*d*.) per rateable poll, and then each town was compared to other towns with regard to real and personal property to determine how much should be added to each town's poll tax to fill its equitable share of the revenue sought from the tax. A town judged

Table 7.4 Tax Rates on Land Usage (in dollars per acre)

County	Date	Tillage	Mowing	Meadows	Pasture
All towns	1786	1.41	1.67	0.99	0.50
	1801	1.18	1.85	1.12	0.58
Suffolk/Norfolk	1786	1.86	2.11	1.05	0.72
	1801	1.54	2.25	1.17	0.73
Essex	1786	1.61	1.90	0.99	0.55
	1801	1.57	2.33	1.11	0.63
Middlesex	1786	1.48	1.70	1.03	0.51
	1801	1.27	2.11	1.36	0.68
Hampshire	1786	1.21	1.55	0.94	0.45
	1801	1.04	1.75	1.07	0.50
Plymouth	1786	1.26	1.52	0.96	0.38
	1801	1.06	1.67	1.01	0.49
Bristol	1786	1.39	1.60	0.99	0.45
	1801	1.05	1.73	1.00	0.52
Worcester	1786	1.39	1.64	0.83	0.49
	1801	1.12	1.69	1.01	0.56
Berkshire	1786	1.30	1.53	0.88	0.47
	1801	0.94	1.39	1.00	0.50

Source: Calculated from Town Tax Valuation Lists, 1786, 1801, Massachusetts State Archives.

While the tax rate on tillage in all towns declined between 1786 and 1801, the rates on all grasslands—on mowing, meadow, marsh, and pasture—rose; and mowing was taxed in each town as the most highly valued use of land.[21]

If agricultural improvement dictated a shift from native to cultivated grasses, we should also see a retreat from pasture—of all cleared acreage on Massachusetts farms, the most hilly, rocky, swampy, overgrown, "impoverished and skinned" (Bidwell and Falconer 1925, 102). Yet, for the state as a whole, acreage in pasture between 1771 and 1801 increased more than any of the other barometers we have been tracking, and increased as a proportion of

to be poor would derive more of its quota from the tax on polls than from the tax on property. Assessors in each town were instructed to come up with the full quota, but there was considerable room for discretion, for not all property was taxed and rates were seldom if ever assessed on full value. Even during the period when the law required full valuation—1777–81—the practice of 30–40 percent underassessing continued. The authority on this is still Burbank (1915). Pages 90–235 of this dissertation are available in typescript in the Massachusetts State Library, State House, Boston.

21. "Woodland and unimproved lands" paid increased taxes as well. It was the only land use taxed on an ad valorem basis—at 2 percent of market value. The increased burden of taxes on woodland came from a dramatic 37 percent rise in the market value of woodlands between 1786 and 1801.

Of course, to measure the real burden of rising per acre tax rates over time, comparisons should be made in constant dollars. According to my farm price index, there was a 21 percent increase in the level of farm-gate prices between 1786 and 1801. Thus, many of these tax rates increased less than the rate of inflation.

both improved and total farm acreage in most counties. There are several possible explanations for the expansion of pasture. First, keeping land in pasture for anywhere from three to seven years was a way to fallow tillage in rotation after two or three crops had been taken off, and to the extent that this was true, the increase in pasture would signal *more* careful husbandry—that is, more land in rotation—not less. Second, by 1801 the number of grazing animals (cattle, oxen, and horses) was more than two and a half times what it had been in 1771, and larger herds required more summer pasture even if considerable efforts were being made to stable and stall-feed animals for the rest of the year.

But these benign explanations for increased pasture acres fall before the farmers' own judgments concerning the quality of their pasture lands. Between 1771 and 1801 there was a 17 percent decline in the number of cows *per acre* that farmers reckoned their pasture "will keep"—a subjective but important measure. Whatever improvement in the carrying capacity of an acre of pasture had been realized between 1771 and 1792 was more than offset by the decline in its carrying capacity between 1792 and 1801 (see table 7.1). Pasture acreage had increased because pasture quality had unquestionably deteriorated, so that by 1800 more land was required to support each grazing animal.[22]

For the average farmer to have attempted to reclaim this, the uncultivated, overgrazed, exhausted 20 to 40 percent of his land,[23] would have required, at the very least, intensive manuring. Cattle can be viewed as curious machines: "they are the best machine for turning herbage into money" (Massachusetts Society for Promoting Agriculture [MSPA] Papers, 1807, 48), yes, but even more importantly, they turn herbage into manure. Each cow or ox that is stabled all winter consumes in that time two tons of hay from which it produces two loads of manure (at thirty bushels a load), and an additional load if yarded at night during the summer.[24] At thirty loads to the acre (the rate often cited for manuring tillage and mowing), it would have taken ten cows eating three tons of hay apiece for a year to manure one acre![25] There were horses, swine, chickens, and sheep to help, of course, and there were nonanimal sources of fertilizers, but with over 2,800 acres of pasture in the average Massachusetts town in 1801, the effort was formidable. Small wonder that one farmer from the hill country protested to the MSPA: "If you have rocky pas-

22. Perhaps "required" is an exaggeration. In a multiple regression analysis in which the dependent variable was "number of cattle owned" in 131 towns in the 1771 valuations, Bettye Hobbs Pruitt found that while "tons of hay" explained 89 percent of the variation of the dependent variable, the introduction of the variable "acres of pasture" increased the explanatory power of the regression by a mere 0.3 percent (Pruitt 1981, 183).

23. Bidwell goes so far as to say that the distinction the valuations made between pasture and woodlands—that is, between pasture and unimproved—"was probably not of great importance" (Bidwell and Falconer 1925, 120).

24. MSPA Papers, 1800–1807, responses to their "Inquiry" of 1800, questions 38–44.

25. In the 1790s, Dr. Nathaniel Ames of Dedham, brother of Fisher Ames, spread *400 loads of manure per acre* (at thirty bushels, or one yard cubed, to the load) to cover the soil three inches deep! His memorandum book is at the Dedham Historical Society.

ture, to subdue it would cost the whole value of the farm . . . . It makes no sense to cultivate [it] till our country shall count as China does its 270 million souls."[26]

Fortunately, improved animal husbandry in Massachusetts did not need to wait upon the reclamation of depleted pasturelands. The combination of summer out-pasturing in the hill country and stall feeding the rest of the year on corn and English hays, whose yields *per grazing animal* were rising, proved sufficient, even with inferior pastures, to support a very large increase in grazing stock. (Table 7.1 confirms both assertions.)

And it did more: livestock were increasing both in number and in *weight*, and the "edible weight" of hogs and beef cattle had a direct bearing upon the nutrition, health, and standard of living of the human population.[27] From farm account books and probate inventories I have collected 385 hog weights from 1750–1850. Standardizing slaughter and dressed weights to a live-weight basis,[28] the twenty-six observations that I found before 1800 averaged 164.5 pounds; the next twenty-six observations, from 1800 to 1816, averaged 287.3 pounds. The first 400-pound hogs appeared in 1801.

If it is indeed the case that "grain supplies offer clearer evidence of meat production capacity than do . . . animal inventories" (Gallman 1970, 18),[29] and if the weight gains in my small sample are representative, it suggests that we err in modeling grains and livestock, corn and hay, tillage and mowing as if they were *substitute* uses of resources. Animal husbandry is a thickly tex-

26. *New England Farmer*, August 3, 1822.

27. "[A]mericans achieved an average level of meat consumption by the middle of the eighteenth century that was not achieved in Europe until well into the twentieth century . . . . Americans achieved modern heights by the middle of the eighteenth century [and] reached levels of life expectancy that were not attained by the general population of England or even by the British peerage until the first quarter of the twentieth century" (Fogel 1990, 36). Fogel cites as his evidence of Americans' meat consumption Sarah F. McMahon's study of widows' portions in Massachusetts wills (McMahon 1981, 4–21). It is *Massachusetts farmers* who achieved this level of meat consumption.

28. I describe in Rothenberg (1981, 306) how I converted the sample of adult hog weights to live weights. For the convenience of the reader, I will repeat it here. In each case a determination had to be made as to whether the weight given in the farm account books was a live or dressed weight, and there are few clues in the sources themselves. I compared the per pound price of the hog (usually given) with the per pound price of fresh pork for that region in that year. If the per pound price of the hog was less than the price of fresh pork, the weight was called a live weight. If the per pound price of the hog equaled or exceeded the price of fresh pork, the weight was called dressed weight and divided by 0.70 to standardize all weights to live weights. The dressed weight/live weight ratio of 0.70 was chosen because it lies midway between the figure of 0.75 (or 0.76 used by some authorities) and 0.65 used by others.

At the time these calculations were being done, I assumed that dressed weight was the proper measure of the accessible nutriments in meat. Apparently there is still another correction to be made: to multiply dressed weight by 0.64 to reduce it to "edible weight" (Fogel 1990, 53 n. 14).

29. In Massachusetts it was not only grain supplies but skimmed milk, root crops, and legumes in animal feeds that determined meat production. As a consequence (presumably), Massachusetts hogs, fattened for one month, weighed more in 1800 than southern hogs, fattened for four months, weighed in 1860. The average live weight of Massachusetts hogs, calculated from probate inventory appraisals, was 224 pounds in 1780–1805; the average live weight of southern hogs, as estimated by Gallman, was 192 pounds in 1860 (Gallman 1970, 15).

tured web of complementarities made possible only by the increased yields achieved in tillage agriculture, which in turn is made possible only by the continuous improvement of manure achieved in animal husbandry. Corn, small grains, root crops, and legumes grown on richly manured soils were both consumption goods and intermediate products that along with nutritious grasses produced rich manures, fat cattle, dairy products, meats, hides, wool, energy, and the natural increase of animals after their kind. In addition to grasses, animals used every part of the cereal plants: the grains for feed, the straw and stover for fodder and for bedding; the stubble for forage, and what was not consumed by grazing livestock as "after-feed" was composted into "green manure" to augment animal manure. The process was profoundly circular.

A circular process was transformed into a growth process. It took the form of better management of livestock, manures, woodlots, fruit orchards, cultivated meadows, seed selection, stall feeding, and dairying. Legumes and root crops were both nutritious in feeds and nitrogen-fixing in rotation. Land clearing, fencing, and connecting farm buildings were part of the restructuring of farm space. None of these improvements required more capital, but all called for more labor inputs, more effective labor hours, the application of know-how learned by doing, and the reorganization of farm work. If, in the course of the development process, agriculture's share of the labor force goes down, then an increase in agricultural output per *capita* can be achieved only by a very great increase in agricultural output per agricultural *worker.*[30] Where is that increase to come from if, as late as the 1840s, there was virtually no capital deepening—that is, no technological change—in New England agriculture? From endogenously generated intensification in the use of labor. "Labor is the great thing in farming" (Larkin, 1989).

Lacking the kind of task- and crop-specific evidence of man-hour inputs that Parker and Klein (1966) and Atack and Bateman (1984, 1987) have collected for a later period, it is difficult to determine how the agricultural improvement visible in tables 7.1 and 7.2 was being achieved. But conspicuous among the techniques available to Massachusetts farmers to manage productivity growth was the employment of farm laborers (who usually lodged with the family) to do general farm work on monthly contract.[31] Workers paid a flat monthly wage for the duration of a long-term contract were accepting an implicit wage below the marginal productivity wage they might have negotiated

30. Paul David's "conjectural estimating equation" to measure growth in a two-sector economy is $O/P = LF/P \times [S_a(O/LF)_a + S_n \times k(O/LF)_a]$, where O/P is output per capita, LF/P is the labor force participation rate, S_a is the share of the labor force in agriculture, S_n is the share of the labor force in nonagriculture, both of which are weights on sectoral output per worker, and k is the ratio of the sectoral outputs per worker in the base year.

31. For a fuller discussion of the employment of contract labor in Massachusetts agriculture, 1750–1865, see Rothenberg (1992).

on a day-labor basis in season, in return for room, board, and an implicit wage above the value of their marginal product in the off-season (Lebergott 1964, 245; Goldin and Engerman 1991, 7, and table 2). Employing farmers, faced after the Revolution with wage competition from an increasingly integrated labor market, would have seen in the reorganization of farm labor an opportunity to hoard scarce labor, to minimize search costs, to hedge against the rising and increasingly differentiated wage structure that was emerging at the end of the eighteenth century (Rothenberg 1988, figure 1), and to increase the effectiveness with which labor was used.

Slavery and serfdom aside, the options available to farmers wherever wage labor is scarce are the same: cash tenancy, sharecropping, a cottager system, or labor contracts. Of these, Massachusetts farmers came increasingly to rely on labor contracts. I report briefly here on a larger study (Rothenberg 1992). The principal data come from a sample of 693 monthly contracts I have drawn from forty farm account books for the period 1750 to 1865. They are supplemented by a data base of 210 contract workers hired, beginning in 1787, to work on the Ward Farm in Shrewsbury, Massachusetts.[32]

Monthly contracts appeared in farm account books early in the eighteenth century,[33] but there was a threefold increase over time in their incidence, from an average of thirteen contracts per quinquennium before 1800 to an average of over fifty per quinquennium after 1800. The most rapid increase began at our "turning point," 1785: by 1814 the number of contracts per five-year period had soared from seven to seventy-three. That the acceleration in the use of monthly labor occurred at about the same time as the acceleration in the growth of labor productivity compels us to examine what relation may have existed between them. What role, if any, might this reorganization of the farm labor force have played in increasing total factor productivity?

The most obvious advantage of labor under contract is that it lessens search time (transactions costs) for both parties. Less obvious and more complicated is the impact of monthly labor contracts on seasonality in agriculture. To the extent that a live-in "hired hand" is (for the term of his contract) a piece of fixed capital—like a slave—the farmer's challenge is to keep him fully occupied. New England agriculture, which is so profoundly seasonal, would seem for that reason to be as unlikely a setting for a long-term contract as it was for slavery, and for some of the same reasons: an idle live-in worker was "an under-utilized asset which nonetheless required maintenance" (Anderson and Gallman 1977, 25). A surly young man of unknown family sleeping under

32. The Ward data base was compiled at Old Sturbridge Village under the direction of Jack Larkin, chief historian, in the Research Department, and generously made available to me by him.

33. The first agreement for monthly labor that I have found was in Boxford, Massachusetts, in 1713. Rev. Ebenezer Parkman of Westborough hired live-in labor on six-month contracts beginning in 1726 (Beales 1989). Joseph Barnard of Deerfield began regularly to hire monthly workers in 1753. In addition to Beales's study of Parkman's hired hands and Larkin's study of the Wards' farm laborers, volume 99 of the *Proceedings* of the American Antiquarian Society also contains Richard Lyman's study of workers on the Levi Lincoln farm in Oakham, Massachusetts.

your roof, eating (ravenously) at your table, wheedling to use your horse and to borrow cash against his wages, requiring of your wife that his clothes be washed and mended, posing a constant threat to your daughter, and expecting at the end of his term to be paid in full is a powerful incentive to organize your farm so that he is worked hard and continuously.[34]

If, despite the inexorable seasonalities of northern agriculture, Massachusetts farms were sufficiently diversified to employ a "fixed" labor force for much of the year, it would follow from the Anderson and Gallman argument that contract labor on Massachusetts farms, like slave labor on southern plantations, may have worked to enhance the productivity of the enterprise by compelling the reorganization of farm work to secure its year-round employment. Two kinds of evidence might be helpful here: Was there an increase in the length of labor contracts over time? Was there an increase in the frequency of off-season (winter) contracts, regardless of their length?

There is little evidence in my sample of any time trend in the average length of contracts. Although more than 10 percent of the contracts were for periods of nine to twelve months, there were only nine years when the average man-months per contract exceeded seven. This may speak to seasonalities in New England farming that resist efforts at distributing work more evenly across the year. Or it may have quite different implications.

Despite the obvious advantages of fixing a labor force in place, employing farmers may have been reluctant to lock themselves into lengthy and intimate commitments to unreliable men, strangers to the community, frequently absent, frequently drunk, and frequently quitters. Genealogical linking, by researchers at Old Sturbridge Village, of the sample of 210 farm laborers who worked on the Ward Farm in Shrewsbury reveals the following: half the day workers but only one-quarter of the contract workers were born in Shrewsbury; the average age of day laborers was 41.6 years, while the average age of contract workers was only 26.5 years; over 80 percent of the day workers were married, while over 86 percent of the contract workers were unmarried; the proportion of contract workers born abroad (England and Scotland at first, Ireland and French Canada after 1830) was more than double that of day workers.

I am suggesting that the *quality* of the agricultural labor supply—or the

34. I am put in mind, as they say, of an entry in Ebenezer Parkman's diary. On June 2, 1739, he was told of the "Rude and Vile conduct of John Kidney [his indentured servant] towards my Dauter Molly." (Molly—real name Mary—was fourteen at the time). Kidney had "button'd the Door and assaulted and Striven with her, thrown her on the Ground and was very indecent towards her, Yet was not suffer'd to hurt her—except what was by the Fright and bruising her arms in struggling with her. When disengag'd She ran out to go to her uncles, but he ran after her and forc'd her back and made her wash the Blood from her arms." John made promises but two weeks later was discovered to have stolen Mrs. Parkman's comb; he put on his best stockings to cut bushes in, and continued to exhibit "his Stubborn Stomach." Parkman threatened to send him to the house of correction, but in the end "accepted Johns Humiliation on his Knees with flowing Tears," and sold his indenture (Walett 1974, 64–65).

perception of their quality—may have deteriorated as a consequence of labor market integration,[35] creating not only a dual labor market in agriculture (at least in the short run),[36] but, increasingly over time, one that operated *perversely.*[37] Casual (part-time) day work was being done by stable men with roots in the community—kin, neighbors, and the sons of neighbors—while steady work on contract was, to a greater and greater extent, being done by casual men: transients, migrants, passersby who "come here to work," hired—quite literally in the case of the Wards—off the road (Larkin 1989, 197). Agreements frequently began cautiously, conditionally—"if he live with me a year," "no stated time agreed upon to stay," "if I want so long," "if we like," "if he is faithful and learns to work well"—with the starting wage to be raised if things worked out. The employing farmers were justifiably wary of long contracts; the record is strewn with sudden quits.[38]

Even if the average length of labor contracts in my sample did not increase to span the seasons, short-term contracts would have worked to offset seasonality if an increasing proportion of them were for off-season work. The number of winter contracts increased markedly from 4 in 1750s to 143 between 1800 and 1809. Overall, 24 percent of the man-months under contract in my sample were for winter work. Granted that no task made the manpower demands that haying did, farm work in Massachusetts was sufficiently varied to be almost a year-round enterprise. And to the extent that there was double-

35. It will be recalled from the Davis-Gallman-Hutchins project on whaling that whaling, too, suffered after 1820 from the deterioration in the quality of crews when alternatives ashore became more attractive. They estimate that productivity in whaling fell 0.3 points between 1820 and 1860 as a consequence of a 52 point increase in wages ashore (Davis, Gallman, and Hutchins 1989, 136).

36. I do not intend, by the use of the term "dual labor market," to engage in a political controversy over whether the market for rural labor "worked," in the neoclassical sense. After all, unlike race, ethnicity, gender, and educational deficits, the contract workers who were too young, too single, too uprooted, and too Irish would in time become as old, as married, and (even if not as rooted) as "American" as more respected workers. Nevertheless, in the short run they were identifiable as having limited options.

37. Dual labor market theory distinguishes between primary and secondary labor markets. A primary labor market is "composed of jobs . . . which tend to be better jobs—higher paying, more promotion possibilities, better working conditions, and more stable work. The secondary labor market . . . contains the low-paid jobs that are held by workers who are discriminated against and who have unstable working patterns" (Cain 1976, 1222).

"There are distinctions between workers in the two sectors which *parallel* those between jobs" (Doeringer and Piore 1971, 65; emphasis mine). In calling the market for rural labor "perverse," I wish to make the point that with respect to the steadiness of the work, the distinctions between workers in the two sectors (that is, between daily and monthly laborers) did *not* parallel those between the jobs.

38. The word *contract* is being used loosely throughout this section. What I am calling a contract is an entry in the employing farmer's account book or diary. (I have found only one instance when both the farmer and the worker signed their agreement.) The fact that over 10 percent of my sample contracts were terminated by worker quits would suggest that these arrangements were not legally binding. On the other hand, those state courts that denied relief to workers who sued for wages withheld when they quit took these agreements to be express contracts that barred an action on *quantum meruit.* For a debate on the judicial treatment of farm contracts in the early nineteenth century, contrast Horwitz (1977) and Karsten (1990).

cropping of winter rye and winter wheat—sown after the harvest in August and reaped in the spring—even grain farms needed labor "off-season."

Increments to the quantity and quality of factors of production will produce *growth*, but only structural change effects the transformation we call *development*, and it is structural change, more than mere growth, that distinguished the antebellum New England economy from all other regions in the country. Among the most important structural changes that take place in an agricultural economy is the shift of resources to sectors with economies of, and increasing returns to, scale. If these can seldom if ever be realized within the physical plant of a New England farm, we should look for signs of a shift of resources out of farming.

To seek evidence of developmental structural change within the limited categories of taxable property, we will judge those towns to be developing most rapidly where the agricultural sector bears a diminishing proportion, and nonagricultural property an increasing proportion, of the total tax burden.[39]

As early as 1647, the General Court authorized taxation not only on polls and real estate, but on the income from "mils, ships and all smaller vessels, merchantable goods, cranes, wharfes, and all sorts of cattell and all other visible estate" (Felt 1847, 237). In 1771, the state taxed (and therefore the valuations enumerated) shops, tanneries, slaughterhouses, pot- and pearl-ash works, warehouses, vessel tonnage, wharf footage, ironworks, bake houses, distilleries, sugar houses, gristmills, sawmills, slitting mills, fulling mills, stock in trade (goods in process and merchandise inventories), and money at interest (net of debts on interest). In 1786, money on hand (including bank deposits) and debts were added and taxed at 6 percent; and in 1801, annual income from holdings of U.S. and state securities, bank stock, and shares in bridges, toll roads, and turnpikes were added and taxed at 6 percent.

The expansion of the nonagricultural sector can be inferred from table 7.5, which shows that in all counties agricultural property, averaged across towns, paid a decreasing share—and nonagricultural property an increasing share—of taxes.[40] Within counties, the variance *among towns* in the same years, and for the same towns *between years*, is striking. Even excluding Salem and Boston, the range in 1786 extended from towns where agriculture paid over 90 percent of total taxes, to towns where agriculture paid less than 4 percent. While the range did not appreciably narrow by 1801, individual towns experienced the retreat of agriculture. The agricultural sector in Freetown (Bristol

39. By agriculture's share of the tax burden, I mean the share of each town's total tax liability accounted for by the taxes on acres of tillage, mowing, meadow, marsh, pasture, woodlands, and head of livestock. Cider was not included because, although it had been enumerated in all three valuations, it was not taxed in 1801 and hence had no tax rate in 1801.

40. Because the 1771 valuation list does not include tax rates at all, we can only trace the changes in tax rates between 1786 and 1801.

Table 7.5 Taxes on Agriculture as a Percentage of Total Taxes

County	Date	Mean	Range: Highest	Range: Lowest
All towns[a]	1786	.74 (.14)		
	1801	.66 (.13)		
Hampshire	1786	.78 (.09)	.90 (Heath)	.55 (Springfield)
	1801	.71 (.07)	.89 (Shelburne)	.50 (Springfield)
Worcester	1786	.75 (.09)	.85 (Hubbardston)	.57 (Worcester)
	1801	.69 (.05)	.78 (Hubbardston)	.49 (Worcester)
Berkshire	1786	.82 (.05)	.92 (New Ashford)	.71 (Windsor)
	1801	.75 (.05)	.86 (Southfield)	.67 (Pittsfield & Stockbridge)
Suffolk/Norfolk	1786	.71 (.10)	.91 (Chelsea)	.52 (Hingham)
	1801	.61 (.10)	.46 (Chelsea)	.44 (Hingham)
Essex	1786	.55 (.22)	.76 (Lynnfield)	.03 Newburyport
	1801	.47 (.24)	.69 (Lynnfield)	.01 Newburyport
Middlesex	1786	.71 (.17)	.80 (Hopkinton)	.39 (Medford)
	1801	.66 (.11)	.79 (Boxborough)	.19 (Charlestown)
Plymouth	1786	.70 (.12)	.91 (Kingston)	.39 (Plymouth)
	1801	.56 (.15)	.78 (Halifax)	.20 (Plymouth)
Bristol	1786	.78 (.08)	.93 (Freetown)	.61 (Taunton)
	1801	.61 (.12)	.52 (Freetown)	.29 (New Bedford)

Source: Calculated from Town Tax Valuation Lists, 1786, 1801, Massachusetts State Archives.
Notes: Standard deviations are in parentheses. Taxes on agriculture are the sum of taxes on tillage, mowing, meadow and marsh, pasture, woodlands, and livestock.
[a]Boston and Salem, as in all these tables, are excluded from "all towns."

County) moved from paying 93 percent of taxes in 1786 to paying just over 50 percent; and in Kingston (Plymouth County) agriculture moved from paying over 90 percent of taxes in 1786 to just over 30 percent fifteen years later.

Stock in trade is of course only one index of commercialization, but it deserves special attention. It is the measure of inventory investment in the era before GNP accounting, measuring as it does the value of tools and goods in process found in artisanal shops,[41] and the magnitude of merchandise stocks in retail and wholesale shops. Shops and stores occupy places in a dendritic

41. A considerable literature is emerging on the transitional role played by artisanal shops in the industrialization of southern New England. Deeply rooted as they were in traditional rural society, they occupied a place on a continuum between farm and factory—part farmers, part craftsmen, part industrial worker. Shadrach Steere, a woodworker who made bobbins for the Slater mills in Rhode Island, continued to farm all his life. His farm protected him from the vicissitudes facing the urban artisan, while his craft protected him from the risks confronting New England farmers in the early nineteenth century (Sokoloff 1984, 351–82; Cooper 1987). I draw the reader's attention to the following as yet unpublished papers written for conferences at Old Sturbridge Village: Carolyn Cooper and Patrick Malone, "The Mechanical Woodworker in Early nineteenth Century New England as a Spin-off from Textile Industrialization" (1990); Robert B. Gordon, "Edge Tools in Context" (1990); Martha Lance, "Upper Quinebaug Mill Survey: Testing the Waters of Industrial Development" (1987).

marketing network.[42] When, around 1800, the little inland town of Shrewsbury found a market in Boston—ninety miles away—for its cheese, butter, chickens, veal, pork, and hay and in Brighton for its cattle, it was in large measure because Artemas Ward's General Store was a node in a proliferating network of symbiotic enterprises stretching from Worcester County to Boston along the two that ran through Shrewsbury. Stores, and peddlers as well, not only expanded the marketing perimeters of farmers qua suppliers, but played an important role in fashioning among farm families a demand for store-bought goods the insatiability of which may very well have been one of the "kicks" that got agriculture moving.[43]

Market-led productivity growth is a harsh process, one that produces both winners and losers. Presumably the towns in table 7.5 that lay on the yonder edge of developmental change, the towns that by 1801 still derived 70, 80, or 90 percent of their taxable wealth from farming, were among the losers. Perhaps the most politically significant group of losers in Massachusetts history were the followers of Daniel Shays, whose rebellion affords an opportunity to explore the economic contours of what is for me one of its most resonant attributes: the fact that it happened in 1786, *annus mirabilis* in the time path of rural market integration and agricultural productivity growth. Can differential access to the emerging market economy, and to the differential agricultural productivity growth that was its consequence, explain why some Massachusetts towns supported the insurrection, others supported the state, and still others produced leaders for both sides?

Table 7.6 relates proxy measures of agricultural productivity in "Shays country" to town sympathies in the rebellion.[44] While we are fortunate to have a tax valuation exactly contemporaneous with the event, two serious obstacles inhere in this source. First, because the 1786 valuations are aggregated to the town level, we are compelled to aggregate our two variables—both of which

42. On the importance of distribution networks in the growth of consumer demand, and the role that proliferating retail shops played in those networks, see Shammas (1990, 225–90).

43. "Peddlers were central to this process of creating a market structure in ante-bellum America . . . . They inaugurated a commercial revolution which swept away the village culture which had nourished them leaving us with some of their products and a rich folklore. Rural residents were less concerned with resisting the intrusion of capitalism than with articulating their own mode of indigenous commercialization. Peddlers were a part of this articulation as much as were farmers—their roles were different but they were part of the same world—a world which they were both unintentionally destroying" (Jaffee 1990).

44. I owe my attribution of town sympathies in the rebellion to Brooke (1992). Brooke determines the allegiance of towns in the three western counties on the basis of warrants, arrests, indictments, imprisonments, the Hampshire County Black List, and lists of militia leaders.

See also Marini (1986), who uses church histories, minutes of Baptist and Presbyterian associations, and sermons to characterize the town by characterizing its minister and his relation to his congregation. Marini also extends his analysis to the pockets of Shaysite sympathy in the eastern counties of Bristol and Middlesex.

Brooke has a sophisticated social-history (as distinguished from economic-history) interpretation of the rebellion in his *Heart of the Commonwealth* (1989, chap. 7).

Table 7.6 **Comparing Towns Supporting and Opposing Shays's Rebellion with Respect to Selected Agricultural Productivity Proxies**

	Shaysite	Militia & Conflicted
No. of polls	206	257
No. of barns	75	103
Tillage (acres)	673	938
Tillage assessment = acres × tax rate ($)	855	1,243
Mowing tax rate ($)	1.51	1.63
Meadow (acres)	342	669
Meadow tax rate ($)	0.85	0.91
Meadow assessment = acres × tax rate ($)	297	611
Pasture (acres)	1,177	1,611
Cider (barrels)	336	700
No. of head of livestock	1,320	1,589
Livestock assessment = no. head × tax rate ($)	592	761
Money on hand ($)	77	135
Debts ($)	438	2,151
Stock in trade ($)	259	1,176
Total tax ($)	4,948	6,934
Aggregate taxes on agriculture ($)	3,380	4,685

Source: Town Tax Valuation Lists, 1786, Massachusetts State Archives.

Notes: The 128 towns in "Shays Country" (the three western counties of Massachusetts in 1786) were partitioned into two groups according to the measures of allegiance cited in n. 44. For each category enumerated in the 1786 valuations, group means were calculated. The categories shown in this table are those for which the difference between the means is significant at the <.05 level (with the exception of number of head of livestock, where the difference between means was significant at the .09 level).

are, after all, decisions made on the individual level—to the town level. We are forced to say that the *town* has or does not have Shaysite sympathies, that the *town* is or is not realizing increases in farm labor productivity. The second major problem is the failure of the 1786 valuations to enumerate any outputs (except cider). This, of course, seriously compromises our efforts to generate productivity estimates. Lacking any alternative, I am compelled to argue that the striking variance in *tax rates* on land in the same use in different towns, and on lands in different uses in the same town, can serve as a proxy for the differential income-earning capacity of these lands.

The experimental design consists of testing, with respect to each of the taxable magnitudes in the valuations, the differences between the means and the variances of two groups of towns: those with Shaysite sympathies, on one hand, and on the other, those opposed, either because they supported the state militia or because they produced leaders for both sides. The magnitudes in the 1786 valuation that are not included in table 7.6 are those for which the means between the two groups of towns were not significantly different from one another at the 5 percent level.

The two-way contingency tables in table 7.7 rank the same two groups of

Table 7.7 Two-Way Contingency Tables Relating Shaysite Sympathy to Agricultural Productivity Proxies

	Total Tax		Agricultural Taxes		Agriculture/ Total Tax	
	0	1	0	1	0	1
Anti-Shays towns	31	44	33	42	32	43
Pro-Shays towns	26	8	26	8	21	13
Chi square	11.6		9.9		3.4	
Significance level	.001		.002		.06	

Sources: Town Tax Valuation List, 1786, Massachusetts State Archives, for the 128 western towns in "Shays Country." For attribution of town sympathies see sources at n. 44.

Note: "Anti-Shays towns" are those that supported the state militia and conflicted towns that produced leaders for both sides. "Agricultural taxes" are the assessments on tillage, grasslands, and livestock. "Agriculture/total tax" is the share of total assessments paid by taxes on agriculture.

towns by the frequency with which each group of towns fell above (1) or below (0) the mean of all 128 western towns in "Shays country" with respect to selected items in the 1786 valuation. The chi-square test results allow us to assert that the two groups of towns were significantly different from one another with respect to three proxy measures of the performance of agriculture.

Shaysite towns lay significantly below the mean (0), and non-Shaysite (militia and conflicted) towns lay significantly above the mean (1) with respect to total taxes assessed, the assessment on agricultural property, and the proportion of the tax paid by agricultural property. In other words, the towns that did not throw their lot in with the insurrection had significantly more prosperous agricultural enterprises than did the towns supporting the insurrection.[45] Given the intractabilities in the data referred to earlier, I interpret these results as confirming my surmise that whatever its significance as an event in anti-Federalist politics or democratic populism, Shays's Rebellion seems now to loom as a deeply conservative impulse, a fist shaken at impending change. The danger to the Shaysites came not from the "competitive capitalism of merchants,"[46] but from *within* the farm economy, poised, as it was quite literally in 1786, on the cusp of structural transformation.

Shays's Rebellion serves to illustrate the serious political consequences of uneven rural development, but my purpose in introducing this material at this time is to use the association confirmed in tables 7.6 and 7.7, between the

45. This does not contradict the discussion on pp. 329–31 measuring economic development by a *decline* over time in the proportion of total taxes paid by the agricultural sector. Recall that the movement out of agriculture has to do with the shift between 1786 and 1801, whereas this analysis of what we may call the economic origins of Shaysite sympathies has to do with the towns' relative status at a point in time, in 1786.

46. This is the view of David P. Szatmary (1980) and others who see the rebellion as an agrarian defense of the moral economy against merchant capitalism. I am suggesting that the enemy they faced was agrarian capitalism.

political polarities in 1786 and agricultural productivity measures, to reverse the direction of the inquiry. Having run a causal chain from agricultural improvement to partisanship in the insurrection, I propose now to run the chain backward, from partisanship in the insurrection to agricultural improvement, in order to suggest which towns may be presumed to have had access to the market in 1786 and which did not. Since the argument sounds circular, let me schematize it. There are three propositions here: A is a proposition about productivity; B is a proposition about market access; and C is a proposition about sympathies in the insurrection. I consider the link between A and C to have been demonstrated by the results in tables 7.6 and 7.7. I consider the link between A and B to have been demonstrated many times over in my published work. If C and B are both linked to A, then they are linked to each other, and allegiance can be used as presumptive evidence of market access, or the lack of it.

I suggest, then, that of the 128 towns in the western counties, the 34 towns loyal to the rebels were probably "locked out" of access to markets in 1786; and that the 75 anti-Shays towns, in addition to those that remained hors de combat, were in varying degrees "locked in " to a market economy, had in varying degrees embraced, as it were, the new dispensation, and were, by 1786, enjoying its consequences for productivity growth.

I have focused deliberately in this paper on a very narrow period—one I had elsewhere identified as a turning point in farm labor productivity—a point in time too narrow, I had feared, to register in the behavior of lumpy aggregates. But I submit that in this analysis, based principally on town tax valuations of 1771, 1786, 1792, and 1801, the turning point stands confirmed.

We might still ask, why? Why did the productivity turnaround happen at the end of the eighteenth century? Why did farmers choose that time to respond to market signals in a new way? Questions of that kind, if they have any answer at all, tend to have a great many answers. One was suggested at the beginning of this paper: the process may have begun as a Smithian feedback loop in which falling real wages, increased output, extended markets, and division of labor worked together to generate more of the same. But if so, that process was apparently embedded in a far more profound one: a change in climate regimes. The market-led transformation of Massachusetts agriculture was set against a major regional climate shift between 1750 and 1850. And the two phenomena, I suggest, may not have been unrelated. Confronted by a long transitional regime of hazardously unpredictable weather, reorganizing the farm to achieve total factor productivity growth may have been perceived as the only way to succeed by farming.

Weather happens both on a scale so large that we can speak of a "global climate" and on a scale so small that places a mile apart can have different "weathers." But that it is important to agriculture, even if not decisively so, goes without saying. (Which may explain why so far in this paper it has gone without saying!) Extremely important work on New England's climate history and its relationship to agricultural change is being done now, and the results, however preliminary, may cast light on dating the transformation of Massachusetts agriculture.[47]

The years 1750–1850 are identified by climate historian William R. Baron as a "change-over" period, an interval caught in the shift from one major climatic regime to another. The earlier regime, called the neoglacial, was "a time of somewhat cooler temperatures, prominent polar anticyclones, southwardly displaced depression tracts, and considerable blocking of upper winds by high pressure cells over Iceland and the northeastern Atlantic." The later regime was a "very different" pattern of warmer and more stable weather. Seventeen fifty to eighteen fifty, like all such transitional periods, was marked by great instability, by heightened variability in all the relevant parameters: in "growing season length, storm frequencies, snowfall, droughts, and harsh and unusual weather" (Baron 1990, 1). From the point of view of the farmer, it is this *variability* in the weather, far more than the weather itself, that increases his risks and endangers his enterprise. And risk there was: in thirteen out of the twenty-four years—more than half—between 1750 and 1774, there appear to have been too few "growing degree days" in Cambridge, Massachusetts, for the corn to mature at all.[48] The most extreme instance of eccentric weather was 1815, which had the longest growing season by far—240 days between killing frosts!—of any year between 1750 and 1970, followed the very next year, 1816, by the so-called year without a summer, which had a growing season of only 80 days, by far the shortest.[49] For any one year during the eighteenth century, a Massachusetts farmer could anticipate that the last killing frost before spring planting could happen anytime between the eleventh of March and the fourteenth of June; and that the first killing frost in the fall (which would destroy at least half his crop) could come anytime between the twenty ninth of August and the seventeenth of November (Baron 1984, 318).

Risks on this scale—uninsurable, random, devastating—dwarf the risks of producing for market. Confronted by a Nature that must certainly have appeared to play dice with the Universe, production for market becomes a *risk-aversive* strategy. And in 1801, it must really have looked as though the enhanced yields, changes in output mix, intensified use of labor, spatial reo-

47. In the discussion of climate and weather to follow, I shall be summarizing, to the best of my ability, the work of William R. Baron, supervisor of the Historical Climate Records Office, Northern Arizona University, Flagstaff, Arizona 86011, and colleagues (Baron 1982a, 1982b, 1984, 1985, 1989, and 1990). I am deeply indebted to Prof. Baron for generously sharing his extraordinary work with me.

48. This is how I interpret Baron (1989, fig 1, p. 21).

49. The length of the growing season is one of the variables that can be expected to affect yields. It may therefore be relevant to the agricultural magnitudes in the valuations used in this study. At 212 days, 1771 had the longest growing season, save for the extraordinary summer of 1815; 1786 had 152 days; 1801 had 190 days.

rientation of farm functions, shift of capital out of agriculture, and perceptible gains in total factor productivity—all achieved under the aegis of the market—would indeed save Massachusetts agriculture.

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Comment Jeremy Atack

Writing in 1916, Percy Bidwell advanced what was then, or, certainly, what was to become, the conventional wisdom regarding New England agriculture at the start of the nineteenth century:

> it was most inefficiently, and, to all appearances, carelessly conducted. Very little improvement had been made over the primitive methods employed by the earliest settlers. As soon as the pioneer stage had passed and the clearing of the land had been accomplished, the colonists settled down to a routine husbandry, based largely on the knowledge and practices of English farmers of the early seventeenth century, but in many ways much less advanced than the agriculture of the motherland even at that early date . . . improvements of far-reaching significance had been introduced in English agriculture . . . yet the bulk of the farmers had shown no disposition to adopt the new methods. On their poorly cultivated fields little fertilizer of any sort was used, their implements were rough and clumsy, live stock was neglected, and the same grains and vegetables were raised year after year with little attempt at a rotation of crops, until the land was exhausted. (1916, 319)

This view has become so entrenched in our consciousness that it permeates the currently popular texts in economic history and is central to most models of U.S. regional specialization and development.[1] Surprisingly, it has also managed to avoid critical scrutiny for decades. Just as well—for it now appears to rest upon very shaky ground. Indeed, such views are no longer tenable, thanks in large part to the work of one scholar—Winifred Rothenberg.

Over the past fifteen years or so, she has assembled a large body of evidence from primary sources, both qualitative and quantitative, bearing on the condition of agriculture in the quintessential New England state—Massachusetts—between the late colonial period and the mid-nineteenth century. This evidence from farm account books, county records, and the like, her weaving of a coherent, consistent narrative theme, and her careful analysis of the quantitative data lead inescapably to the conclusion that farmers in Massachusetts, at least, were engaged in market production throughout the period, were responsive to market signals, mobilized capital, and were willing to change habits when the incentives were right.[2]

Rothenberg's paper here draws heavily upon her published work, especially her study of the farm labor market (1988). The crucial finding there was that

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1. For examples of this conventional wisdom in current American economic history texts, see Hughes (1990, 32–33) or Walton and Rockoff (1990, 49–50, 89). The best-known model of regional specialization and development in the United States during the nineteenth century is that of Douglass North. See North (1961, 1966). See also Field (1978).

2. Market production and responsiveness to market signals: Rothenberg (1981). Capital markets: Rothenberg (1985). Adaptability: Rothenberg (1988).

labor productivity, as measured by the farm labor wage rate deflated by a wage-good price index—actually Rothenberg's own farm-gate price index (1979)—was declining until about 1780 and rising from sometime after 1790 until perhaps the 1830s or 1840s (Rothenberg 1988, 558, figure 4). It is this result that Rothenberg seeks to buttress here.

The evidence she presents is in three forms. First, she finds evidence of increasing specialization in crops with higher labor value-added such as dairy products and hay. Second, she presents evidence showing that Massachusetts farmers changed the organization of farm labor. Third, she concludes that yields per acre were rising. However, as I shall explain below, each of these pieces of evidence, whether in isolation or together, fails to make a cast-iron case that labor productivity was rising at an average annual rate as high as 0.5 percent (Rothenberg 1988, 559n.35). This rate of growth is almost certainly biased upwards.

Nevertheless, I am unwilling to reject her conclusion that labor productivity was rising, if only because it is consistent with a growing body of evidence from other parts of the country about this time. For example, Ball and Walton find that there was very modest growth in total factor productivity in Chester County, Pennsylvania, agriculture before the Revolution, a slight setback during, and a modest resumption of growth immediately following the Revolution (1976, especially 110). Similarly, Adams's work on wages and prices in Maryland with commodity-deflated wage rates indexed to the 1780s implies rising labor productivity after that date (1986, especially 638, table 5). For the country as a whole, Gallman concludes that labor productivity in corn, oats, and wheat grew at about 0.3 percent per year between 1800 and 1850 (Gallman 1975, especially 47).

The crux of my critique derives from her use of the labor productivity defined as output, Q, per unit of labor input, L:

$$q_L = Q/L$$

Data constraints and the existence of multiple outputs, however, generally lead—as they do here—to the measurement of output by the aggregate value of output, that is Q is proxied by

$$\sum_i Q_i P_i$$

where Q_i is the output of the ith crop that sells for price P_i.

The obvious problem here is that price changes, driven by demand, may be confused with changes in physical output in this measure. But, we may be doubly sure that this is not the case here, for not only is Rothenberg's price index for farm products in Massachusetts but it is also for farm-gate prices—that is, it removes the effect of impact in transportation and distribution cost changes. Prices and price expectations, however, do play a crucial role in the allocation decision of farmers—how much to plant of each crop. Here, Rothenberg's argument is that Massachusetts farmers adopted higher revenue-producing crops and that this led to increased productivity. It seems unlikely that this technological shift identified by Rothenberg was an illusion even though much of the evidence is drawn from tax valuations.

Leaving aside the philosophical question of the impact of this implicit deviation from profit maximization upon productivity, the question is, why didn't farmers adopt the higher revenue-producing crop mix earlier? The answer is *not* that this option did not exist before: farmers were quite familiar with dairy and hay production long before they practiced them to the extent that they came to. Indeed, it was probably *because* they were familiar with these crops that they did not adopt them earlier! Although these crops produced higher revenues, they required greater effort. They are examples of Boserupian-innovations (Boserup 1965). Reluctance to put forth this increased effort then delays adoption until economic or physical survival makes it a matter of necessity. This issue thus bears upon the first two pieces of evidence used by Rothenberg.

The problem with this kind of technological change is easiest to see in the case of dairy production. The dairy demands year-round attention, twice-a-day milking, not to mention the cleaning of the milking shed, cooling the milk, churning, and so forth, and it also goes hand-in-hand with intensive stall feeding of hays and root crops, themselves more labor-intensive crops (see, for example, Bateman 1969). This intensification of effort—measured by more work effort per hour, increased hours per day, and more workdays per year—should, of course, be captured in the measure of labor input, L. The question, though, is, Is it?

I am not convinced that it is. Rothenberg's evidence pertains to labor contract terms and daily wages, not work intensity and man-hours. Are six one-month contracts the same quantity of labor as one six-month contract? I don't know, but I suspect not. One reason why is that rational employers would seek to retain the better worker by offering more attractive—such as longer—contract terms. Longer, and more frequent long-term, contracts are consistent with increased labor requirements throughout the year, and higher daily wages are consistent with either greater productivity or longer hours and greater effort. What is not mentioned is what happens to the farmer's own labor and that of unpaid family members, particularly his wife. Ideally what I would like to see is an accounting of labor hours by task (such as those reported for grain crops by Parker and Klein, 1966 later in the nineteenth century) for all paid and unpaid labor, including that of the farmer and that bound to the farmer by affection, filial devotion, or whatever and how this changes over time. If the necessary contemporary data do not exist in farmers' daybooks, the periodical literature, travelogues, and the like, perhaps time and motion studies at historic farm museums such as Old Sturbridge Village will offer some insight.

Rothenberg's third piece of evidence in defense of her argument that labor productivity was rising is that yields per acre were rising. If all land was currently under cultivation and remained in crops, increased yields necessarily imply increased output and hence higher labor productivity *ceteris paribus:*

$$\sum_i (Q_i/A_i)A_iP_i/L,$$

where A_i is acreage planted in the *i*th crop so that Q_i/A_i is the yield per acre for this *i*th crop. The evidence here, though, is very tenuous, being just for two year, 1771 and 1801. Nothing is said about conditions in these two years, though presumably some newspaper accounts of general weather conditions, the state of the harvest, and so forth, might be found. Even so, though, yield estimates contain large stochastic elements reflecting local weather variations that swamp any short, or even medium, -term trend. Indeed, yields show tremendous variations from farm to farm, township to township, year to year that a much, much longer run of data is needed before any broad sweeping statement is warranted.

Finally, while I am very sympathetic to the argument that Massachusetts agriculture was much less backward than the conventional wisdom has argued and believe that Rothenberg's evidence clinches the case, this paper contributes relatively little to this broader question. Although it starts out addressing the question of whether or not the real farm wage-farm labor productivity nexus holds and farm labor productivity was rising from the 1790s, its focus is actually upon a much narrower time frame from the late 1770s to the early 1780s—a period when fluctuations about the long-term trend are largest and the trend itself is obscured—with data that are themselves widely separated discrete observations.

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