

The Efficiency of Quebec Farmers in 1851

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It is generally accepted that Quebec agriculture experienced some form of structural "crisis" in the nineteenth century from which the province only gradually recovered. Recently, Frank Lewis and Marvin McInnis have produced two econometric studies of output and efficiency in the census year 1851-52 that seem to justify a major rethinking of Quebec agriculture before mid-century. This research report attempts to weigh the importance of the Lewis and McInnis findings. A detailed look at their method of estimating efficiency suggests that Lewis and McInnis's results fail to resolve any of the major issues concerning Quebec agriculture.

Il est généralement admis que l'agriculture québécoise connut, au XIX^e siècle, une certaine « crise » structurelle de laquelle la province ne se releva que graduellement. Cette orientation est remise en question dans deux études économétriques publiées récemment par Frank Lewis et Marvin McInnis, qui mesurent la production et la productivité agricoles en 1851-52 (année de recensement). Cette note de recherche veut précisément évaluer les mérites de la révision majeure que semble autoriser la démonstration statistique de Lewis et McInnis. Un examen détaillé de leur méthode pour estimer la productivité indique qu'elle n'apporte aucune réponse satisfaisante aux problèmes majeurs en matière d'agriculture québécoise.

The understanding of Quebec agriculture in the nineteenth century presents a challenge to economic historians that will remain for years to come. Despite the volume of historical writing on the period, there is little consensus on most basic issues. This is largely attributable to the unreliability of census data on agricultural production prior to 1870 and the absence of comprehensive price indexes. Yet nineteenth-century Quebec agriculture played an instrumental role in determining the region's subsequent economic growth rate and structure. As late as 1900, rural areas still accounted for 64 percent of the province's population. The behaviour of agricultural producers in the nineteenth century is an important element in the understanding of twentieth-century provincial growth rates, the structure of production, and the pattern of income distribution among French and English.

It is widely accepted that Quebec agriculture experienced some form of "crisis" in the nineteenth century from which the province only gradually recovered. Although the precise nature of the "crisis" is unresolved, it seems to have been associated with a trend decline in net agricultural output per farm worker in the first half of the century. The timing of the onset of this crisis is unclear,¹ but its existence in

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1. See, for example, Fernand OUELLET, *Histoire économique et sociale du Québec, 1760-1850* (Montreal: Éditions Fides, 1966), chap. 7; Gilles PAQUET and Jean-Pierre WALLOT, "Crise agricole et tensions socio-ethniques dans le Bas-Canada, 1802-1812: Éléments pour une ré-interprétation", *Revue*

the 1830s and 1840s is taken for granted by most historians of the period. The crisis seems to have affected French-speaking producers to a greater extent than the English-speaking minority. By mid-century, however, the entire agricultural sector is believed to have partially recovered. The character of agricultural growth and change after 1850 is not well understood, but there seems to have been a gradual shift in the composition of output from cereals to dairy produce, a shift that accelerated in the 1890s. It appears that rural income per capita was significantly lower in Quebec than in Ontario and the northeastern United States. This income differential would explain the high emigration rate of Franco-Quebecers during the second half of the nineteenth century.

Frank Lewis and Marvin McNinnis have recently produced two studies of agricultural output and efficiency in Quebec at mid-century. In the first study the authors compare the efficiency of French- and English-speaking farmers: they conclude that the prevailing view of Quebec agriculture as characterized by a sharp demarcation between the two language groups is unfounded. Using revised data from the 1851-52 census of the Canadas for a selected sample of counties, Lewis and McNinnis conclude there was no significant total factor productivity differential between French and English.² In the second study the authors undertake two additional tasks: a county-by-county estimation of net agricultural output per farm worker for the entire province, and an analysis of the large variations in total factor productivity across counties.³

Lewis and McNinnis suggest their results are applicable to the 1830s and 1840s, and that a major rethinking of the agricultural "crisis" is in order. Indeed the authors appear to question the very existence of a structural crisis before mid-century. In a recent review article McNinnis writes:

Some readers may wonder if I am essentially denying that there was an "agricultural crisis" in Lower Canada at all. I readily acknowledge that there are important questions to be resolved about the state of the agricultural economy in Lower Canada. In the first half of the nineteenth century some significant problems were met and some major adjustments had to be made. Whether these were as unique to Lower Canada as has often been implied is less obvious, and it is not at all clear whether the situation is usefully described as one of "crisis". A final judgement cannot yet be made. What has been written to date on the topic may have served as much to confuse as to further our understanding.⁴

d'histoire de l'Amérique française, 26, 2 (September 1972): 185-237; T. J. A. LE GOFF, "The Agricultural Crisis in Lower Canada, 1802-12: A Review of a Controversy", *Canadian Historical Review*, 55, 1 (March 1974): 1-31; Robert ARMSTRONG, *Structure and Change: An Economic History of Quebec* (Toronto: Gage Publishing Co., 1984), chap. 6.

2. Frank LEWIS and Marvin MCINNIS, "The Efficiency of the French-Canadian Farmer in the Nineteenth Century", *Journal of Economic History*, 40, 3 (September 1980): 497-514.

3. Frank LEWIS and Marvin MCINNIS, "Agricultural Output and Efficiency in Lower Canada, 1851", Queen's University Discussion Paper No. 451 (November 1981), forthcoming in *Research in Economic History*.

4. R. Marvin MCINNIS, "A Reconsideration of the State of Agriculture in Lower Canada in the First Half of the Nineteenth Century", *Canadian Papers in Rural History*, 3 (1982): 10. See also LEWIS and MCINNIS, "Agricultural Output", p. 6, where the authors state, "... the census of 1851/52 provides us with a picture of the agriculture of Lower Canada at the end of an era. If there had been any recovery from the depressed conditions of the 1840's it must have been very slight and can hardly have altered relatively long-standing conditions."

The Lewis and McInnis results provide a key element underlying these assertions. This review attempts to weigh the importance of their findings. A detailed look at Lewis and McInnis's method of estimating efficiency suggests that, though the questions asked are of interest, their numerical results fail to resolve any of the major issues concerning Quebec agriculture in the nineteenth century.

I — EFFICIENCY AS MEASURED BY TOTAL FACTOR PRODUCTIVITY

In their 1980 study, Lewis and McInnis focus on one aspect of agricultural production—efficiency or productivity. Rather than employing a partial productivity index, such as the average product of labour, the authors use a multifactor productivity index designed to measure agricultural output (Q) per unit of labour (L), capital (K) and land (T) combined:

$$(1) \quad A = \frac{Q}{F(L, K, T)}$$

where A is total factor productivity. This measure consists of a geometric index derived from a Cobb-Douglas production function with constant returns to scale of the following form:

$$(2) \quad Q = A \cdot L^\alpha K^\beta T^\gamma \quad \alpha + \beta + \gamma = 1$$

where α , β , and γ are the output elasticities of labour, capital and land respectively. Equation (2) can be rewritten as:

$$(3) \quad A = \frac{Q}{L^\alpha K^\beta T^\gamma}$$

The specification of the production function as Cobb-Douglas allows the income shares α , β and γ to be used as proxies for the contribution of the various inputs to total output. By this procedure, the residual "A" can be interpreted as a measure of total factor productivity. In other words, the residual left over after the total product has been attributed to the inputs L, K and T is taken as a measure of the way in which resources are combined—the total factor productivity associated with farming. The ratio of total factor productivity between the two language groups is:

$$(4) \quad \frac{A_E}{A_F} = \frac{\frac{Q_E}{Q_F}}{\left(\frac{L_E}{L_F}\right)^\alpha \left(\frac{K_E}{K_F}\right)^\beta \left(\frac{T_E}{T_F}\right)^\gamma}$$

where the subscripts E and F designate English- and French-speaking producers respectively.

This measure of comparative efficiency is the same formulation employed by Fogel and Engerman to advance the hypothesis that the antebellum agricultural economy in the southern United States, and particularly the plantation slavery system, was more efficient than the free family farm in northern states.⁵ Lewis and McInnis have borrowed this controversial proposition from the slavery literature and adapted it to Quebec agriculture. They argue that total factor productivity did not differ significantly across French and English farming districts in 1851—as startling a contention as Fogel and Engerman's initially was.

Lewis and McInnis's empirical estimate of the productivity differential is developed as follows. Rewriting equation (2) in logarithmic form gives:

$$(5) \quad \ln Q = \ln A + \alpha \ln L + \beta \ln K + \gamma \ln T$$

The precise form of the production function estimated by Lewis and McInnis is then:

$$(6) \quad \ln Q = A_F + \left(\ln \frac{A_E}{A_F} \right) D + \alpha \ln L + \beta \ln K + \gamma \ln T + u$$

where $D = 0$ for French-language districts and 1 for English-language districts, and u is a randomly distributed error term.⁶ A test of the null hypothesis that $\frac{A_E}{A_F} = 0$ provides a test of the hypothesis that there is no difference in the total factor productivity associated with producers of the two language groups. The basic result of estimating equation (6) for the entire sample of 90 parishes and townships is:

$$(7) \quad \ln Q = 2.295 + 0.018 D + 0.355 \ln L + 0.159 \ln K + 0.486 T$$

(9.488) (0.413) (5.441) (9.895) (9.985)

where t -statistics are given in parentheses, $R^2 = 0.963$ and $F(2,85) = 6.342$. The t -statistic for the variable "D" suggests the total factor productivity differential between the two language groups is not significantly different from zero at a 0.5 confidence level. The coefficients of the other variables are all significantly positive.

In a second calculation, the authors examine alternative hypotheses by increasing labour's share to 0.55 and 0.7 while maintaining $\alpha + \beta + \gamma = 1$. The results

5. Robert W. FOGEL and Stanley L. ENGERMAN, "The Relative Efficiency of Slavery: A Comparison of Northern and Southern Agriculture in 1860", *Explorations in Economic History*, 8, 3 (Spring 1971): 353-67, and "Explaining the Relative Efficiency of Slave Agriculture in the Antebellum South", *The American Economic Review*, 67, 3 (June 1977): 275-96.

6. The parameters α , β , and γ are constrained to sum to unity. The ratio $\frac{\beta}{\alpha}$ is constrained to "reasonable values" by imposing equality with the $\frac{K}{T}$ ratio prevailing in 1860.

indicate a measured productivity differential in favour of English-language producers ranging from 8.2 to 18.6 percent. The productivity differential estimate is reduced when four broad regions within Quebec are compared individually.

II — THE PRODUCTION FUNCTION APPROACH TO AGRICULTURAL EFFICIENCY

The use of the aggregate production function, which governs the behaviour of total factor productivity in equations (1) through (7), is a controversial technique in theory and application. The logical consistency of the approach depends upon highly restrictive assumptions concerning the underlying technology. Some of the assumptions required by Lewis and McInnis's specification include the following: the absence of risk and uncertainty; a high degree of substitutability among inputs; the equality of factor prices, factor marginal productivities, and the rate of return of land and capital; and constant returns to scale. Any errors stemming from misspecification of the function will spill over to affect the $\frac{A_E}{A_F}$ ratio. Moreover, the properties of the production function depend on the proper aggregation of inputs and outputs. The capital stock in agriculture, for example, typically consists of a heterogeneous collection of goods that cannot be added together except in nominal terms. Capital is essentially a value concept that is affected by changes in relative factor prices. Unless the factor price frontier is a straight line, the same method of production can be the most profitable at more than one rental rate. With the assumptions adopted by Lewis and McInnis, the production function will not necessarily exist. All of this, of course, is familiar to those who have followed the growth accounting literature.⁷

For some, the possibility of "reswitching" and "capital reversing" is sufficient reason to reject the production function approach to economic analysis and the empirical results generated by Lewis and McInnis. In what follows, it will be assumed that "reswitching" and "capital reversing" phenomena were absent from the technology that characterized Quebec agriculture in 1851. This is a heuristic device that allows a fuller exploration of the Lewis and McInnis results. It will be shown that a number of conceptual and measurement errors remain which cast further doubt on their conclusions.

Suppose that "well-behaved" sectoral production functions exist and their form is the following:

$$(8) \quad Q = A(t) \cdot F(L, K, T) \quad \begin{array}{l} F_L, F_K, F_T > 0 \\ F_{LL}, F_{KK}, F_{TT} < 0 \end{array}$$

7. See, for example, M. Ishaq NADIRI, "Measurement of Total Factor Productivity: A Survey", *Journal of Economic Literature*, 8, 4 (December 1970): 1137-77; Richard R. NELSON, "Recent Exercises in Growth Accounting: New Understanding or Dead End?", *American Economic Review*, 63, 3 (June 1973): 462-68; Murray BROWN, "The Measurement of Capital Aggregates: A Postswitching Problem," and the "Comment" by Edwin BURMEISTER, in *The Measurement of Capital*, ed. Dan USHER (Chicago: The University of Chicago Press, 1980), pp. 377-431.

There remains the problem of specifying the two functions that accurately describe French and English agricultural production in 1851. The magnitude of the $\frac{A_E}{A_F}$ ratio depends critically on the particular form of the function that governs F_L , F_K and F_T for each language group. The traditional literature can be interpreted to imply that the spectrum of techniques accessible to the two groups was different.⁸ Lewis and McInnis assume not only that the two production functions possess exactly the same form, but that they are both accurately described as Cobb-Douglas with constant returns to scale.⁹ Neither of these assumptions is supported by any discussion or evidence.

Suppose the production functions describing the spectrum of techniques facing the two language groups are identical. *A priori*, there is no way to choose between a pair of Cobb-Douglas production functions (with unitary elasticity of substitution) and Hicks neutral technical change from a pair of production functions with an elasticity of substitution less than one and labour saving technical change. Both interpretations may be equally consistent with the same data. However, the former specification lowers the estimate of the differential between the two indexes of total factor productivity relative to the latter specification. In choosing the Cobb-Douglas specification, the authors have introduced a bias favourable to their conclusion that the productivity differential is insignificant.

Suppose the form of the two production functions has been correctly specified. It is clear that the magnitude of the residual differential will depend on the manner in which total output is attributed to the factor inputs,¹⁰ and the accurate measurement of Q , L , K and T for each language group. Any measurement errors will affect the magnitude of $\frac{A_E}{A_F}$ in one direction or the other. In fact, it can be argued this ratio should reduce to unity if all outputs and inputs are correctly measured. The residual $\frac{A_E}{A_F}$ should therefore be taken as a measure of ignorance, an index of those inputs that have been omitted or inaccurately measured. Lewis and McInnis are aware of this and offer their results as an indication of the *maximum* productivity differential between the two language groups. In other words, they argue that any corrections to their admittedly crude index would tend to *reduce* the measured productivity

8. See Robert L. JONES, "French-Canadian Agriculture in the St. Lawrence Valley, 1815-1850", *Agricultural History*, 16, 3 (July 1942): 137-48; Jean HAMELIN and Fernand OUELLET, "Les rendements agricoles dans les seigneuries et les cantons de Québec, 1700-1850", in *France et Canada français du XVII^e au XX^e siècle*, eds. Claude GALARNEAU and Elzéar LAVOIE (Québec: Presses de l'université Laval, 1966), pp. 81-141. This difference could be attributed to differences in know-how related to the language barrier and schooling that slowed the rate of diffusion of new techniques originating in American agriculture after 1830.

9. The authors assert that increasing labour's share over a range of values (with constant returns to scale) "should accommodate possible differences in ethnicity in factor shares that might arise from a different factor input proportions combined with non-unitary elasticities of substitution", but do not delve any further into this issue. LEWIS and MCINNIS, "Efficiency of the French-Canadian Farmer", p. 503.

10. In his discussion of growth accounting, Nelson comments, "The problem is the same one that plagued the profession many years ago when it was trying to attribute total product (rather than growth) between the different factors. We learned then that this was impossible. We could attribute at the margin. But there was no way of attributing shares of the total". NELSON, "Recent Exercises", p. 465.

differential. It is therefore essential that the estimating procedure eliminate any bias tending to diminish their estimate of the "true" differential between the two language groups. In the following section is a discussion of measurement errors ignored or downplayed by Lewis and McInnis in the first of their two papers. Most of the same errors are repeated in the second paper which is discussed in a subsequent section.

III — THE ESTIMATION OF FARM OUTPUT AND INPUTS

The point of departure for Lewis and McInnis's estimating procedure in the 1980 article is a non-random sample of Quebec districts. Anglophones represented about 20 percent of the rural population in 1851. In order to proceed with two sample groups of comparable size working with similar land quality and atmospheric conditions, the authors carefully pre-select the districts to be studied. This is no small task since French and English farmers often lived in close proximity. Judging from their Figure 1,¹¹ the English-language producers included in the sample are those in outlying regions with poor access to the markets of Montreal and Quebec City. None of the high productivity English-language farmers in the greater Montreal region are included in the sample.¹² Almost all of the French-language districts chosen for study are closer to the two principal domestic markets than are the English-language districts. Furthermore, extensive areas of predominantly French settlement, particularly on the north shore of the St. Lawrence, are left out. It therefore appears the selected districts for each language group are atypical and the sample is not representative of the total agricultural population.¹³ Any statistical results, however valid, should be taken as referring only to the authors' non-random sample of districts.¹⁴

The relative efficiency of French-language producers will be overstated to the extent their farm output is overestimated relative to that of English producers. In calculating the total volume of farm output by each language group, poultry, eggs, garden vegetables, honey, wax, tallow, textile and farm forest products are left out. The authors assert "there is no reason to believe that the excluded components of output favour either French or English."¹⁵ Of the farm products included in the

11. LEWIS and McINNIS, "Efficiency of the French-Canadian Farmer", p. 502.

12. Jones stresses that Argenteuil, Beauharnois, and especially Isle de Montréal and Isle de Jésus contained the most efficient English-language farms. ROBERT L. JONES, "The Agricultural Development of Lower Canada, 1850-1867", *Agricultural History*, 19, 4 (October 1945): 212.

13. In "Efficiency of the French-Canadian Farmer", Lewis and McInnis claim "there is no good reason to suspect that the excluded districts were on average either more or less efficient than those excluded in the study." (p. 501) However, they later state that "a larger proportion of the English districts were located in areas of Lower Canada where agricultural productivity, French or English, was relatively high." (p. 511) The use of non-random samples in econometric analysis has recently been criticized in EDWARD E. LEAMER, "Let's Take the Con out of Econometrics", *American Economic Review*, 73, 1 (March 1983): 31-43.

14. The pre-selected nature of the sample and the limited scope of the results are sometimes less than clear in the authors' summary of their own work. See LEWIS and McINNIS, "Agricultural Output", pp. 4-5.

15. LEWIS and McINNIS, "Efficiency of the French-Canadian Farmer", p. 504. Census data are not available for poultry and eggs, but they were valuable export products. See JONES, "Agricultural Development of Lower Canada", p. 215.5. Lewis and McInnis claim these items were largely the responsibility of women's labour—an input excluded from their calculations.

index of relative output, a partial adjustment is made for differences in farm animal product quality. Because the 1851-52 census reports only the quantity of livestock, Lewis and McInnis are obliged to devise a measure of annual animal product output and then allow for animal product quality. This latter calculation is especially worrisome: the only source of animal product quality considered is feed crop quantity. In other words, the authors use the same animal output coefficients for all districts, adjusted by uniform animal feed coefficients, and effectively value the additional feed presumably going to higher quality animals as output at market prices.¹⁶ Even if one allows that this procedure may capture some part of animal quality differences, it would not capture much. Original calf quality, cross-breeding, the quality of veterinary services and, especially, the extent of grazing affect the volume and quality of products from a given animal.¹⁷ Lewis and McInnis therefore assume away most of the variations in the total value of animal product output. Since traditional historians such as Robert Jones make considerable issue of a differential in farm animal product quality favourable to English-language producers, this part of the calculation is particularly bothersome.¹⁸

Once an estimate of the volume of outputs is established, this heterogeneous collection of goods can only be aggregated with the aid of some measure of value. Lewis and McInnis aggregate farm output with the aid of prices culled from the Montreal wholesale market (December 1851–March 1852). In other words, their concept of efficiency is defined as the revenue-earning capacity of producers relative to the wants of Montreal consumers — even though, as the authors admit, most Quebec farmers were engaged in subsistence agriculture and presumably insensitive to relative prices in the Montreal marketplace. Furthermore, with the exception of animal feed, no allowance is made for possible differences in product quality between the two linguistic groups. Nor is any allowance made for regional variations in farm gate prices. Since many English-speaking producers in the Eastern Townships were exporting to the United States, there is no reason to believe that relative prices in Montreal reflected farm gate prices everywhere. Regional price variations are a well established fact in North America economic history.¹⁹ French- and English-language farmers were producing a differing array of agricultural commodities and the choice of a uniform set of prices for all affects the relative valuation of output in unpredictable ways.

The relative efficiency of French-language producers will be overstated to the extent their farm inputs are underestimated. For capital in the form of draft animals, Lewis and McInnis estimate the number of draft animals in each district as a percentage of bulls, oxen and steers in the census, plus the number of horses needed to make up the estimated draft requirements in each district. This latter calculation

16. "If the English, for example, got more beef per steer or more milk per cow than the French, they did so by using more feed." LEWIS and McINNIS, "Efficiency of the French-Canadian Farmer", p. 506.

17. The authors admit their procedure "would have failed to prevent the estimate from being biased in favour of the French if the English farmers followed practices that allowed them to get larger outputs of animal products from given inputs of feed", but go on to discount this possibility. LEWIS and McINNIS, "Efficiency of the French-Canadian Farmer", p. 506.

18. See JONES, "French-Canadian Agriculture", p. 142-44.

19. See, for example, Philip R.P. COELHO and James F. SHEPHERD, "Differences in Regional Prices: The United States, 1851-1880", *Journal of Economic History*, 34, 3 (September 1974): 551-91.

is estimated on the basis of the size distribution of farms reported in the census. The same method is used for the valuation of capital in the form of milk cows and swine.²⁰ No cultural difference between the two language groups is allowed for.²¹ The value of capital in the form of machinery and equipment is assumed equivalent to 5 percent of the total value of livestock, a percentage taken from the 1861 census where more information is available. Again, no English/French differential is allowed for; it is assumed away.

Aside from capital, the accurate valuation of land and labour inputs is also important to the estimation of relative total factor productivity. Lewis and McInnis assume that their selected sample of districts contains an even distribution of land qualities across the two language groups. In contrast to the Fogel and Engerman estimates, no adjustment is made for land quality differences. Thus the greater proximity to the St. Lawrence River of the French-language districts included in the sample is not considered as an indication of greater fertility.²² If variations in land quality favourable to French-language producers did exist, then the measured efficiency differential has been underestimated. No adjustment is made for labour quality either, though this is legitimate if the authors wish to capture the human capital differential in their estimate of the residual. In general, however, Lewis and McInnis measure only the effects of quantitative variations in resources even though variations in the quality of land, labour, capital and output will affect their measure of the efficiency differential in unpredictable ways. The Lewis and McInnis procedure amounts to assuming that, with the exception of livestock as reflected in feed crop requirements, all variations in the quality of inputs favoured Anglophone producers while all variations in the quality of output favoured Francophone producers.

The estimate of the volume of farm labour is, of course, crucial to the calculation of relative efficiency. Unlike the quantity of improved land, the total quantity of farm labour per district is not systematically reported in the census and, as described below, Lewis and McInnis calculate it separately for about a third of their sample. For the other two-thirds, occupations, as reported in the census, are used even though this introduces potential errors.²³ Furthermore, Lewis and McInnis's estimate must be seen as very approximate because it is calculated in man-years. If French-language producers, being poorer, worked harder, this is not captured in

20. Acknowledging that the French districts tended to raise more swine, the authors assume that the number of swine slaughtered was 125 percent of the number enumerated in the census. This, they assert, corresponded to the ratio found in late nineteenth-century Ontario agriculture. Frank LEWIS and Marvin McINNIS, "The Efficiency of the French-Canadian Farmer in the Nineteenth Century," unpublished technical appendix, p. A5.

21. Many of the adjustments made to the raw data are *ad hoc* and even with the aid of the technical appendix an independent researcher would not be able to reproduce the authors' results.

22. The greater fertility of lands proximate to the St. Lawrence River would help to explain the tendency of French-language producers to allocate a higher proportion of their resources to cereal production and less to the production of livestock. Moreover, the greater fertility of these older settled lands is one of the chief conclusions of their 1981 study. LEWIS and McINNIS, "Agricultural Output", p. 36.

23. *Ibid.*, p. 15. As the authors point out in their 1981 paper, "It appears that woodsmen and timber cutters were quite properly returning their occupations but they often had farm residences with small amounts of cultivated land. By using the occupational distribution we are led to understate the amount of farm labour and we exacerbate the matter by making a large adjustment to labour input to take account of the high ratio of occupied to cultivate land." The authors claim that this problem appeared only in the upper Ottawa valley, but it was surely a much larger phenomenon.

the authors' estimate. For one third of the sample, the proportion of labourers and servants attributed to agriculture in each district is taken to be the same as the ratio of farmers to the number of farmers plus others. It is not clear whether this was done on a district-to-district basis, but if not, then another potential cultural difference has been assumed away. Lewis and McInnis do assume that a proportion of the rural population aged 10-14 worked in agriculture, but they ignore any cultural difference even though schooling and, presumably, school attendance rates differed substantially between the two language groups.²⁴

Lewis and McInnis introduce an interesting adjustment to their measure of land inputs on the assumption that some labour time was allocated to land improvement. The estimate is related to the ratio of unimproved to improved land owned in each district.²⁵ But apart from this correction, uniform for both language groups, no other source of differences between the two groups is considered. As the authors later admit in their 1981 paper, "to the extent that improved land was just idle land, to which no labour time was allocated, we have upwardly biased the measure of output per worker in counties where little progress has been made in clearing farms."²⁶ In other words, if English-speaking farmers were improving their lands, while French-speaking farmers, being poorer, allocated proportionately less time to this activity (and more to agricultural production), then Lewis and McInnis's estimates—both the adjusted and the unadjusted results—understate the "true" efficiency differential.

IV — AGRICULTURAL EFFICIENCY ACROSS THE PROVINCE

In their 1981 study, Lewis and McInnis estimate net agricultural output per farm worker for 58 counties (based on 1871 census definitions) and analyse the variations in total factor productivity across these counties. The methodology used to estimate net output is the same as that employed in the 1980 article: uniform output prices; a narrow allowance for animal product output differences; the absence of any cultural differences in the length of the work year or in the time allocated to land clearing; and so on. Although they have almost certainly underestimated the extent of regional variations, the authors express surprise at the wide variability of net output per farm worker across Quebec.

In the latter part of the study, Lewis and McInnis investigate the role of total factor productivity or "efficiency" by returning to the Cobb-Douglas production

24. See Allan GREER, "The Pattern of Literacy in Quebec, 1745-1899", *Histoire sociale-Social History*, 11 (November 1978): 295-335.

25. If $\frac{Q}{L^*} = \frac{\alpha}{1 + b \tau_u}$ where L^* is total labour input applied to both improved and unimproved land, τ_u is the ratio of unimproved to improved land, $a = \frac{w}{\alpha_1}$ and $b = \frac{\alpha_2 \gamma_1 \Gamma_2}{\alpha_1 \gamma_2 \Gamma_1}$, where w is the wage rate and r_1 is the return on land, then $L = L^*/(1 + 0.262\tau_u)$ where the coefficient b has an estimated value of 0.2616. LEWIS and MCINNIS, "Efficiency of the French-Canadian Farmer", pp. 508-9.

26. LEWIS and MCINNIS, "Agricultural Output", p. 17.

function.²⁷ Rewriting equation (2) in per capita terms and assuming $\frac{Q}{L}$ is distributed log-normally, they estimate:

$$(9) \quad \ln \left(\frac{Q}{L} \right) = \ln A + \ln F \quad \text{where } F = \left(\frac{K}{L} \right)^\beta \left(\frac{T}{L} \right)^\gamma$$

in order to determine the relative importance of factor inputs and the residual "A" (the authors' measure of efficiency). The coefficients β and γ are assigned values described as "plausible" and "intermediate" in the light of their 1980 article, but the values are not specified in the text. The estimation of equation (9) for 55 counties (three are left out of this calculation) indicates that the variance of $\ln \left(\frac{Q}{L} \right)$ is 0.063 which decomposes to $\text{var} [\ln A] = 0.031$, $\text{var} [\ln F] = 0.012$ and $\text{cov} [\ln A, \ln F] = 0.010$. Lewis and McInnis conclude that the residual accounts for more of the variance in output per worker than do quantitative variations in land and capital per farm worker.

Having concluded that the residual "A" contributes significantly to the variations in output per farm worker, Lewis and McInnis undertake to identify the sources of the "efficiency" variations. The investigation amounts to a linear regression of the residual on four proxy variables chosen to test the validity of alternative explanations of the residual. The alternatives are: (1) the composition of output or product mix; (2) the distance of counties from market; (3) soil quality; and (4) the degree of soil exhaustion as measured by the recency of settlement. The estimating equation is:

$$(10) \quad A = a + \sum_{i=1}^4 b_i s_i + c \cdot \text{DIST} + d \cdot \text{LQ} + e \cdot \text{AGE} + u$$

where s_i = the share of final output attributable to product i , DIST is an index of distance to the closer of either Montreal or Quebec City, LQ is an index of contemporary soil quality in Quebec, AGE is the ratio of cultivated land in 1831 to cultivated land acreage in 1851, and u is a normally distributed error term. The results of estimating equation (10), as presented by Lewis and McInnis, are reproduced in Table 1.

27. "We are measuring only the effects of quantitative variations in resources. To the degree that variations in the quality of factors of production are important they will show up as variations in total factor productivity." LEWIS and MCINNIS, "Agricultural Output", p. 27.

TABLE 1

Accounting for the Variation in Total Factor Productivity,
Lower Canadian Agriculture, 1851

(Dependent Variable: A)

| | (1) | (2) | (3) | (4) |
|-------------------------|-------------------|-------------------|-------------------|-------------------|
| Number of Counties | 55 ^a | 55 ^a | 55 ^a | 48 ^b |
| Independent Variable | | | | |
| Wheat | 0.54 (0.09) | 0.81 (0.13) | -3.58 (0.52) | -0.92 (0.13) |
| Other Field Crops | 11.50* (1.49) | 12.51* (0.57) | 11.17 (1.40) | 19.00** (2.24) |
| Specialty Products | 8.91 (0.73) | 5.45 (0.40) | 6.69 (0.49) | 8.81 (0.65) |
| Sale of Horses | 29.67** (3.83) | 30.00** (3.84) | 25.84** (3.09) | 18.80** (2.45) |
| Distance | | 0.22 (0.58) | 0.45 (1.06) | 1.81** (2.92) |
| Land Quality | | | 3.02 (1.33) | 6.08** (2.24) |
| AGE | | | | 7.63** (2.79) |
| Constant | 11.98** (4.71) | 11.54** (4.32) | 10.69** (3.92) | 1.36 (0.32) |
| Adjusted R ² | .19 | .18 | .19 | .30 |

(t-statistics are in parentheses).

*Significant at the .90 level. **Significant at the .95 level.

^a Excludes the counties of Bonaventure, Gaspé and Chicoutimi-Saguenay.^b Excludes the counties of St. Jean, Chambly, Bagot, Rouville, Temiscouata, and Rimouski for which cultivated acreages are not recorded for 1831.

Source: Frank LEWIS and Marvin McINNIS, "Agricultural Output and Efficiency in Lower Canada, 1851", Queen's University Discussion Paper No. 451 (November 1981), Table 3, p. 32.

The Lewis and McInnis results indicate that only one of the four variables selected as a product mix alternative to animal husbandry (wheat, specialty products, horse sales and other field crops) is statistically associated with the residual at a 95 percent confidence level. If product mix is an important determinant of the residual, then Lewis and McInnis have failed to capture it at this level of aggregation. They conclude their evidence "does not support the view that counties which devoted more of their resources to wheat came off significantly worse in agricultural productivity."²⁸ In fact, their test does not indicate anything about the relative inefficiency of wheat production, though it could be construed to suggest that wheat production was not a *more* efficient product choice than the others. In any case, wheat, which represented 60 to 70 percent of total field crop production in the eighteenth century declined to less than 15 percent by 1844. At mid-century, the

28. LEWIS and McINNIS, "Agricultural Output", p. 31.

shake-out in Quebec agriculture had already occurred and the relative efficiency of wheat production is a dead issue.²⁹

Lewis and McInnis select "distance from the principal centres of Quebec and Montreal" as their proxy for distance from markets. This ignores the market in New England so important to producers in the Eastern Townships. To no surprise, therefore, the author's DIST variable is not significantly associated with the residual; the counties exporting to the United States would have to be netted out before this test could have much meaning. However, when the variable AGE is introduced (equation [4] of Table 1), the authors' DIST variable displays a significantly positive coefficient which the authors dismiss as "incongruously positive". Since the DIST and AGE variables are negatively correlated,³⁰ this result actually lends support to the contention that agricultural exports from English-language districts proximate to the American border were significant. The conclusion that "distance from the principal urban markets appears not to have been a disadvantage" is based on an incorrect specification and the Lewis and McInnis discussion is therefore misleading.

Lewis and McInnis assert, "the historical literature on the agriculture of Lower Canada points strongly to an expectation that productivity was lower in the older, more settled areas."³¹ They introduce two different measures of soil quality to test the soil exhaustion hypothesis: an index calculated from a 1980 study published by Environment Canada that reflects contemporary soil characteristics irrespective of whether the land is being cultivated today (LQ) and the ratio of cultivated land in 1831 to cultivated land in 1851 (AGE). The first variable is statistically insignificant until the second is added to the regression equation. The inclusion of the AGE variable with a reduced sample, as indicated in equation (4) of Table 1, suddenly renders several of the authors' explanatory variables significant and one must wonder about this curious result. The authors conclude that soil productivity was higher in the older, more settled areas and infer this result contradicts the existing literature.³²

An alternative reading of the existing historical literature suggests Quebec agriculture had arrived at the extensive margin of cultivation by the 1830s. However, price and cost changes, as well as soil depletion, redefined this margin throughout the rest of the nineteenth century. As a result of soil depletion, for example, there were slightly higher returns to land at the extensive margin that made new settlement profitable. But *average* productivity on newly settled lands was low relative to

29. The prosperity of the early 1850s is generally associated with higher yields of all field crops and a short term return to wheat growing. See HAMELIN and OUELLET, "Les rendements agricoles", p. 97.

30. Quebec City and Montreal were two of the earliest settlements in New France. Even in the nineteenth century, extension of agricultural settlement generally represented a move away from these two river ports.

31. LEWIS and MCINNIS, "Agricultural Output", p. 36.

32. In his review article, McInnis questions the existence of soil exhaustion in Quebec agriculture during the first half of the nineteenth century. R.M. MCINNIS, "A Reconsideration", pp. 15-17. His claim that the concept of soil exhaustion has been rejected by modern soil scientists is wrong. Recent studies of wheat on the prairies and monoculture systems in Quebec and Ontario indicate that long run yields will decline in the absence of appropriate farming techniques (fertilizers and so on). The depletion of organic matter, phosphorous and nitrogen will produce a trend decline in fertility over long periods of time. Inclement weather, disease and erosion by wind and water are separate matters of concern. See the symposium on the long term effects of intensive cultivation on soil quality published in the *Canadian Journal of Soil Science*, 60, 3 (August 1980): 393-419.

average productivity in older regions as a result of decreasing returns overall.³³ In other words, the agricultural "crisis" may have been associated with a downward shift of the marginal productivity curve for cultivated land that induced the clearing of new lands at the margin.

In their conclusion, Lewis and McInnis emphasize the heterogeneous nature of production and the wide regional variations in net agricultural output per farm worker. They reject the central tenets of the existing historical literature. As suggested here, the authors' results are hardly as iconoclastic as they would have the reader believe. On the relationship between efficiency and soil quality or distance from urban markets, their tests are inconclusive. On the issues of wheat-growing and the average productivity of older settled areas, they have misinterpreted or unjustly summarized the existing literature.

V — CONCLUSION

There are a variety of reasons why the Lewis and McInnis estimates of the efficiency differential between French- and English-language districts and their discussion of the province-wide efficiency differentials should not be taken at face value. Some of the issues discussed here are touched on by the authors. But whereas they tend to dismiss or downplay any weakness in their studies, this review has attempted to bring such weaknesses to the fore. In many ways the authors have handled serious data inadequacies with care and imagination; but this is not enough to give their results credibility. They may well retort that there is little firm evidence to support some of the alternative hypotheses suggested in this review. Certainly it is desirable to obtain more information on nineteenth-century Quebec agriculture. But even if more information is uncovered, it will be impossible for economic historians to replicate the Lewis and McInnis procedures with the information that the authors have thus far provided.

Some readers may wonder if this review implies a return to the traditional cultural stereotypes concerning French- and English-language farmers. Such is not the case. To suggest there may have been a significant productivity differential between Francophone and Anglophone farmers is not to say that this differential is attributable to a difference in *mentalité* or attitudes toward net income maximization. The differential may have resulted from differences in the institutional environment: the vast majority of French-language producers operated in the seigneurial system while the great majority of English-language producers held land in free and common socage. The structure of incentives embedded in these two systems of property rights varied in ways that may have affected efficiency or total factor productivity.³⁴ Apparently, this is one of the reasons why a programme to phase out the seigneurial

33. The authors find that the volume of cultivated land per person remained at about the same level in 1851 as it had been in 1831. LEWIS and MCINNIS, "Agricultural Output", p. 39. However, the additional lands brought into cultivation over the twenty year period were almost certainly of lower average quality. Total occupied land per person was lower in 1851 than in 1831.

34. See Serge COURVILLE, "La crise agricole du Bas-Canada, éléments d'une réflexion géographique", *Cahiers de Géographie du Québec*, 24, 62-63 (September-December 1980): 193-224, 385-428.

system was introduced in 1854. Lower literacy rates among Francophones and the presence of the language barrier may have slowed the rate of diffusion of new market information and new techniques originating in the United States and Great Britain. French/English differences were smallest where the two groups lived in close proximity. Lower average farm size and income levels, as well as a different product mix, may have slowed the rate of diffusion of new technology and the "efficiency" growth rate among French-speaking farmers. The rational subsistence producer may have been reluctant to shift from the traditional technology and a diversified crop pattern to new techniques and a more specialized crop mix for sale to the market because of the potentially high costs of failure. Risk-averting producers may prefer a pattern of output involving low "mean" incomes with low variance to alternative configurations promising higher "mean" incomes with greater variance. Risk and uncertainty play an important role in the economics of low income subsistence agriculture.

One final aspect of the Lewis and McInnis results that deserves attention is their attempt to draw conclusions about the agricultural "crisis" of the 1830s and 1840s from their study of the 1851 census data.³⁵ Any such inference is invalid. Contrary to what Lewis and McInnis assert,³⁶ economic recovery was already underway in 1848.³⁷ By the time of the 1851 census, agricultural conditions had improved considerably. In 1851 the prospects for the marketing of Quebec agricultural produce were very different from those of ten or fifteen years earlier.³⁸

35. LEWIS and McINNIS, "Efficiency of the French-Canadian Farmer", pp. 500-1; McInnis, "A Reconsideration", p. 23.

36. LEWIS and McINNIS, "Agricultural Output", p. 6.

37. JONES, "French-Canadian Agriculture", p. 148, and "Agricultural Development of Lower Canada", p. 213. HAMELIN and OUELLET, "Les rendements agricoles", p. 97.

38. Consider the impact of rail transport innovations alone. The Longueuil/St. Hyacinthe portion of the Atlantic and St. Lawrence Railway was completed in 1848. As of 1850, the Ogdensburg Railroad, running from Ogdensburg, New York, to Lake Champlain, fed into the Boston and New York City networks. In the autumn of 1851, the Champlain and St. Lawrence Railway completed an extension from Saint-Jean (and Montreal) to Rouse's Point, New York. All of these innovations lowered transport and transaction costs to the port of Montreal and to markets in the United States. See Gerald J.J. TULCHINSKY, *The River Barons: Montreal Businessmen and the Growth of Industry and Transportation, 1837-1853* (Toronto: University of Toronto Press, 1977).