Competitive Pressure and Productivity Growth: The Case of the Florida Vegetable Industry

Nicholas G. Kalaitzandonakes and Timothy G. Taylor

Abstract

The relationship between the degree of competitive market pressure and the rate of productivity growth is empirically investigated with a case study of the Florida fresh winter vegetable industry. The results indicate that crops which faced considerable competitive pressure exhibited significant productivity growth while the crops that faced minimal competitive pressure generally exhibited little growth in productivity. Thus, the hypothesis that competitive pressure is positively related to productivity growth is supported.

Key words: productivity, index, competitive pressure, vegetables

INTRODUCTION

Traditionally, the level of competitive market pressure has been regarded as an important contributor to increased efficiency and technical change. In turn, technical change and increased efficiency are considered to be the principal factors contributing to the growth of productivity. Thus, the degree of productivity growth can be expected to be positively related to the level of competitive pressure in any given market. Factors affecting the degree of market rivalry may also impact productivity growth.

Government intervention in the form of domestic agricultural policies (price supports, etc.) or trade barriers (import tariffs or quotas, etc.), often serve effectively to reduce the level of competition in agricultural markets. It is thus possible for government intervention to have adverse effects on agricultural productivity growth. Antle and Capalbo have noted that in U.S. agriculture "...government intervention may have substantial effects on agricultural productivity in the United States...(p.12)."

An understanding of the relationship between competitive pressure and productivity growth is an important element for the surmisal of long run trends in productivity in all segments of the U.S. agricultural sector. Surprisingly, empirical analysis of the relationship between productivity and competitive pressure has been largely overlooked. Indeed, to the authors' knowledge, there has been no empirical research that has attempted to assess or quantify such a relationship.

The purpose of this paper is to present empirical findings on the relationship between competitive pressure and productivity growth resulting from a case study of the Florida fresh winter vegetable industry over the period 1969 - 1982. Although the results of this study may not be generalized to other agricultural industries, the Florida vegetable industry provides an opportunity to investigate the relationship between productivity growth and competitive pressure for several reasons.

First, fresh winter vegetable crops produced in Florida can be placed into two mutually independent categories based on differential levels of competitive pressure in each market. One set of crops (cucumbers, peppers, squash and tomatoes) are in direct competition with similar products imported from Mexico. The intensity of competition between Florida and Mexico is well documented (Bredahl *et al.*; Buckley *et al.*). The second set of crops (cabbage, celery, sweet corn, eggplant, leaf crops, potatoes, radishes, and watermelons) face virtually no foreign competition and limited domestic competition.

Secondly, new technologies and improved cultural practices were available for adoption for most of the vegetable crops considered during the period of analysis. Thus, there are no apparent differences in the supply of technological advances and comparable rates of productivity growth should have been possible in the production of both sets of Florida crops.

Because of these factors, a comparative analysis of productivity growth rates across these two categories of crops provides the opportunity to shed

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light on the relationship between competitive pressure and productivity growth. If those crops that face substantial competitive pressure exhibit relatively greater rates of productivity growth than those crops that face less intense competition, then the contention that competitive pressure fosters productivity growth is supported.

Section one briefly reviews the existing literature on the relationship between competitive pressure and productivity growth. Section two provides an overview of total-factor productivity measurement using index numbers, and section three presents the data and the empirical results. The final section of the paper presents some concluding remarks.

COMPETITION AND PRODUCTIVITY GROWTH

Increased competitive pressure in a market has generally been considered to be positively related to the level of economic efficiency of a firm by assuming that firms with market power "...are likely to exploit their advantage much more by not bothering to get very near the position of maximum profit" (Hicks, p.8). Liebenstein (1966,1973), on the other hand, argued that the degree of competitive pressure is positively related to the level of technical efficiency; he assumed that allocative efficiency is rather trivial. Empirical studies by Bergsman, and Martin and Page have supported Liebenstein's assertions. Bergsman developed a model for estimating the effects of protective trade measures on both allocative and technical efficiency in six developing countries and concluded that limiting competition in those six countries resulted in significant welfare costs attributable to technical inefficiencies. Martin and Page computed efficiency indices using a frontier production function approach for a cross section of firms in two subsidized industries in Ghana and related differences in the estimated efficiency levels among firms with the presence or absence of subsidy payments. Subsidized firms in both industries were found to exhibit substantially lower levels of technical efficiency than unsubsidized firms. Martin and Page suggested that "One possible explanation of this result is that it reflects an income effect whereby receipt of the subsidy permits managers to relax and indulge their preferences for a quiet life" (p.615).

Competitive pressure has also been positively related to technical change. In the agricultural treadmill hypothesis, Cochrane argued that as technological innovations become available and firms adopt improved technologies, output at both the firm and industry level tend to increase. If market demands are inelastic, increased output results in lower real-output prices and high-cost firms are forced either to innovate to remain competitive or to exit the industry. Similar positions are developed by Kislev and Shchori-Bachrach in their innovation cycle theory. Parallel arguments hold for those products in which international trade is important. When a low-cost foreign competitor enters a market in equilibrium, output prices are driven down by the additional product offered in the market. In the absence of trade barriers, high-cost domestic producers are forced to innovate.

Since improved efficiency and technical change are positively related to productivity growth, the above assertions indicate that competitive pressure is expected to be positively related to productivity growth. Antle, however, has argued that the opposite relationship may, in fact, hold. Specifically, Antle maintained that technical change in dairy production has continued beyond what would have been profitable in the absence of dairy price supports. Hence, it is suggested that price-support policies which, in general, tend to decrease competitive pressure in a market may positively affect technical change and thus productivity growth. This argument is in agreement with Schultz's contentions that government protected and overpriced agricultural commodities are likely to exhibit greater productivity growth as government policies reduce price uncertainty and high prices provide incentive for technical change.

As can be seen from the above studies, there is a consensus that competitive pressure, along with the institutional arrangements that influence it, can significantly affect productivity growth. There is, however, a lack of agreement as to whether the degree of competitive pressure in any given market enhances or inhibits productivity growth.

PRODUCTIVITY MEASUREMENT AND TOTAL FACTOR PRODUCTIVITY

In recent years, total factor productivity (TFP) measures have replaced such partial productivity measures as yield per acre and output per man hour, when measuring technical progress. Any action that leads to an increase in output while holding inputs constant leads to an increase in TFP. This corresponds to shifts in the production surface attributable to technical change. Thus, TFP measures disembodied technical change.

Let $y_t = f(\underline{x};t)$ be a linearly homogeneous, concave twice differentiable and non-decreasing aggregate production function[1], where $\underline{x}$ is a vector of inputs, and t denotes the state of technology. If technical change is assumed neutral[2], following Solow's derivation, TFP growth can be measured as

$$(1) \quad \dot{TFP} = \frac{\dot{y}_t}{y_t} - \sum_i S_i \frac{\dot{x}_{it}}{x_{it}}; \qquad x_{it} = x_{1t}, \ldots, x_{kt},$$

where a dot over a variable indicates its time derivative, and S_i is the output elasticity with respect to the i^{th} production factor. Equation (1) states that the percentage change in output due to technical change equals the difference between the percentage change in total output and the elasticity-weighted percentage change in inputs. If TFP = 0, any growth in output is completely attributable to the growth in inputs. If output growth exceeds that attributable to input growth, then an increase in TFP has occurred.

Technical change and productivity growth as given in expression (1) may be used interchangeably. This correspondence, however, assumes that all the inputs are used in a technically efficient manner. When the efficiency assumption is relaxed, TFP measures both technical change and efficiency growth (Nishimizu and Page). In the present study, continuous technical efficiency is not assumed, and so TFP is taken as measuring both technical change and changes in technical efficiency.

If the production factors are paid their marginal value products, S_i becomes the budget share of the i^{th} input, with $\sum S_i = 1$. Integrating the expression in (1) yields the cumulative index of TFP growth from time t = 0 to t = T,

$$TPF = \frac{\frac{y_T}{y_0}}{e^{\int_0^T \sum_i S_i \frac{\dot{x}_i}{x_i} dt}}$$

The denominator of the right-hand side is the Divisia index of input growth between t = 0 and t = T. Since the right-hand side of (2) involves observable variables, the technical change index could, in principle, be estimated. Such a calculation, however, presupposes continuous time series data that, in practice, do not exist. Therefore, the continuous expression in (2) is generally approximated using discrete data. Several indices have been used as discrete approximations to the Divisia index, including the Laspeyres, Paasche, Fisher's Ideal, and the Tornqvist-Theil index (Diewert 1980).

For many years the choice of which approximation to use for the Divisia index was considered *ad hoc*. However, Diewert (1976) introduced the notion of exact and superlative index numbers which tied the form of index chosen to specific forms of production functions. One result of particular importance was that when f(.) is of the homogenous translog form,

$$(3) \quad \ln f(x_t) = \alpha_0 + \sum_i \alpha_i \ln x_{it} + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln x_{it} \ln x_{jt};$$
$$\beta_{ij} = \beta_{ji} \quad \sum_i \alpha_i = 1 \quad \sum_i \beta_{ij} = 1,$$

the Tornqvist-Theil quantity index can be used in a discrete framework to provide an exact measure of growth in TFP between the base and the t^{th} period. The form of this index is given by:

$$(4) \quad TFP = \frac{\frac{y_t}{y_0}}{\prod_i \left(\frac{x_{it}}{x_{i0}}\right)^{\frac{1}{2}(S_{it} + S_{i0})}} \qquad (t = 0, 1 \ldots, T).$$

Equation (4) can be rewritten in a log linear form to emphasize the fact that the rate of productivity growth is measured as the residual of output growth

[1] In aggregate analysis, consideration must be given to the important issues of consistency in aggregation across inputs and across firms. Consistency in aggregation across inputs and input prices using flexible functional forms and index numbers is discussed in this section in some detail. However, consistency in technology aggregation across firms is assumed given, since secondary data are used in the empirical analysis. For more details on aggregation across firms, see Chambers or Diewert (1980).

[2] Neutral technical change and linear homogeneity are standard hypotheses upon which much of the theory of productivity indices is built. The accounting growth approach to productivity measurement, used in this study, is embedded in the neutrality assumption and thus this hypothesis can not be relaxed. However, the assumption of linear homogeneity can be relaxed at the cost of simplicity in the theoretical developments. For derivations of TFP indices which do not require the linear assumptions see Denny *et al.* and Caves *et al.*.

over that which may be attributable to input growth:

$$(5)\quad \ln\frac{TFP_t}{TFP_0} = \ln\frac{y_t}{y_0} - \frac{1}{2}\sum_i (S_{it} + S_{i0}) \ln\frac{x_{it}}{x_{i0}}$$

Expressions (4) and (5) do not require econometric estimation. This is important in circumstances where the number of inputs relative to the number of observations is large enough to preclude reliable econometric estimation. The TFP index, however, provides a direct measure of productivity growth, derived as the outcome of some optimizing behavior and an assumed form for the production function. Recent empirical applications in various agricultural sectors using the above procedures have been conducted by Heien, Taylor and Wilkowske (1984), and Ball.

EMPIRICAL RESULTS

As noted in the introduction, the Florida fresh winter vegetable industry provides an excellent opportunity to examine the relationship between competitive pressure and productivity growth. Over the 1969-1982 period under consideration, production costs among domestic producers of fresh winter vegetables were similar. However, Mexican producers enjoyed an absolute competitive advantage in terms of production cost (Simmons *et al.*; Zepp and Simmons; and Buckley *et al.*). This suggests differential competition patterns exist for distinct groups of crops in the Florida vegetable industry. For those crops facing only domestic competition, market boundaries are mainly delineated by transportation cost, crop perishability, and production timing differentials. In contrast, production-cost advantages enable vegetables imported from Mexico to compete in markets traditionally supplied by Florida, such as the north and the northeast regions of the U.S. (Howard).

Given these differential patterns of competition, vegetable crops produced in Florida can be partitioned into two independent categories of crops based on the extent of competitive pressures involved in their markets. Cucumbers, peppers, squash and tomatoes, which enter into direct competition with Mexican imports and hence experience considerable competitive pressure, form one such group. The second set of crops which face only domestic competition and have limited market pressure, includes cabbage, sweet corn, eggplant, leaf crops, potatoes, radishes, and watermelon. Measures of TFP for those crops which enter into competition with Mexico have been obtained by Taylor and Wilkowske (1984). A comparison of productivity growth across the two crop groups requires that similar measures be obtained for those crops identified as facing limited domestic competition.

Calculation of TFP indices for each crop required data on yield per acre, cost, and input quantities analyzed over the 1969-1982 period. Yield and production cost data were obtained from Brooke, Taylor, and Taylor and Wilkowske (1983). Input categories used in computing the TFP indices included seed, fertilizer, agricultural chemicals, labor, energy, capital services and a miscellaneous category. Implicit input quantity indices for each input category were generated from regional input price indices obtained from *Agricultural Prices*, and corresponding production cost data by employing Fisher's weak-factor reversal test (Diewert, 1976).

TFP indices were estimated based on equation (5) for each crop over the 1969 to 1982 period, and are shown in Table 1. The TFP indices exhibit considerable variation from one year to another and a general absence of clear trends. In order to gain further insight in relative TFP measures the average annual productivity rates of the crops were investigated. Zohar and Luski provide several different ways in which average annual rates of productivity growth may be calculated. Suggested measures include the use of regression, the arithmetic average, geometric average, and the geometric average of the beginning and ending periods of the annual TFP indices.

In the present analysis, obtaining precise estimates of productivity growth is complicated by the fact that output is measured in terms of yield per acre which can be affected by exogenous factors, such as adverse weather, that can cause large variations in measured output unrelated to input usage or productivity growth. Of all the methods proposed by Zohar and Luski, only the regression method allows the possibility of accounting for effects such as weather in calculating productivity growth. Taylor and Wilkowske (1984, p.54) used regression to calculate what they termed a "normal rate of productivity growth."

Average annual rates of productivity change are derived through a simple regression analysis which accounts for major weather related events. For each crop-area combination an equation of the form

$$(6)\quad \ln\ TFP_{it} = a_{oi} + a_{1i}T + a_{2i}D_i + U_{it}$$

is estimated. TFP_{it} is the TFP index obtained for the ith crop-area combination, T is a trend variable, D is a dummy variable for weather, and the disturbance term U_{it} is assumed well-behaved in the classic sense. The relationship between unreasonably low or high yields and weather is documented through

Table 1. TFP Indices for Selected Vegetable Crops by Production Area. Crop Years: 1969-70 through 1981-82

	Celery		Cabbage	Sweet Corn			Eggplant
Season	Everglades	Central Florida	Hastings	Lower East Coast	Central Florida	Everglades	Palm Beach
1969-70	0.9590	0.8742	0.9103	0.4632	0.6664	0.8297	0.6857
1970-71	1.1617	1.2426	0.9732	0.6025	0.7060	0.8742	0.9317
1971-72	1.1011	1.4376	1.0915	-[a]	0.6355	0.9596	1.0211
1972-73	1.1401	1.0089	1.0551	0.8697	0.7391	1.1356	0.9654
1973-74	1.0704	1.1227	1.1633	0.7638	0.6556	1.1161	0.8917
1974-75	1.0416	1.4506	1.3717	0.9064	0.7177	1.1268	0.9330
1975-76	1.2773	1.4836	1.5264	1.1053	0.7881	1.2045	0.9903
1976-77	1.0221	1.1445	1.1323	0.6662	0.9254	1.1392	1.0436
1977-78	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1978-79	1.2018	1.1810	1.1290	0.9329	0.8142	0.9234	0.9910
1979-80	1.1764	1.1309	0.9869	0.8630	0.8353	1.0036	0.8727
1980-81	1.1543	1.2430	1.2184	0.9571	0.8459	1.1609	0.8974
1981-82	1.0373	1.3675	1.1143	0.7395	0.7361	1.1379	0.9744

	Leaf Crops		Potatoes		Radishes	Watermelon
Season	Central Florida	Everglades	Dade County	Hastings	Everglades	Immokalee/Lee
1969-70	0.4822	1.2319	0.6862	0.8018	1.3911	0.3554
1970-71	0.5290	1.1188	0.6196	0.6996	1.6186	0.7389
1971-72	0.5319	0.9695	0.5742	0.6494	1.1752	0.2667
1972-73	0.6450	0.9426	0.8387	0.8708	1.3904	0.5475
1973-74	0.5439	0.8442	0.7711	0.6788	1.0743	0.4774
1974-75	0.8111	1.1308	0.9063	0.8919	1.7376	0.8152
1975-76	0.8627	1.1213	0.8883	1.0794	1.4141	0.6915
1976-77	0.8434	1.0648	0.5133	1.1564	1.5049	1.4494
1977-78	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1978-79	0.8365	0.8838	0.7546	1.2731	1.0054	0.9500
1979-80	0.8365	1.0553	0.7023	1.0970	1.1213	0.6812
1980-81	0.9377	1.1409	0.6546	1.2152	1.3460	0.8486
1981-82	0.7597	0.8548	0.7006	1.1527	0.9632	0.5886

[a]Data not available

annual issues of the *Vegetable Summary* in which significant weather variations and their effects on annual yields are reported. If these weather variations are captured by the variable D, the parameter $a_{1i} = \frac{\partial \ln TFP_{it}}{\partial T}$ provides direct estimates of the average annual rate of productivity growth. When no extreme weather conditions are observed, equation (6) provides a continuous measure of average productivity growth.

The use of a dummy variable as opposed to other continuous measures of weather is merited for the following reason. The primary weather event that causes significant yield reductions in the Florida vegetable industry is freezing. As included in the study, a major yield-reducing and documentable freeze occurs or it does not. In essence, freezes are considered to be discrete events. No graduations of freezes are considered.

Table 2 presents the parameter estimates of annual average rate of productivity growth for the thirteen

Table 2. Estimated Regression Parameters for Various Vegetable Crops

Crop	Area	Intercept	Trend	Dummy	R-square
Cabbage	Hastings	0.4489 (0.0822)[a]	0.00918 (0.0104)	—	0.07
Celery	Central FL	0.09702 (0.0943)	0.01285 (0.0119)	—	0.09
Celery	Everglades	0.06805 (0.0499)	0.00388 (0.0063)	—	0.03
S. Corn	Central FL	-0.41764 (0.0649)	0.02188 (0.0082)	—	0.39
S. Corn	Everglades	-0.03031 (0.0625)	0.01107 (0.0079)	—	0.15
S. Corn	Lower East Coast	-0.40742 (0.1474)	0.02994 (0.0169)	-0.19863 (0.1681)	0.40
Eggplant	Palm Beach	-0.13650 (0.0510)	0.00912 (0.0076)	—	0.11
Leaf Crops	Central FL	-0.67733 (0.0963)	0.04786 (0.0121)	—	0.58
Leaf Crops	Everglades	0.08478 (0.0711)	-0.00918 (0.0090)	—	0.08
Potatoes	Dade County	-0.33624 (0.1014)	0.00672 (0.0128)	-0.38439 (0.1794)	0.32
Potatoes	Hastings	-0.41246 (0.0767)	0.05061 (0.0097)	—	0.71
Radishes	Everglades	0.41151 (0.1034)	-0.02514 (0.0130)	—	0.25
Watermelon	Immokalee Lee	-0.65603 (0.2206)	0.04389 (0.0269)	-0.79731 (0.3770)	0.51

[a] Standard errors in parentheses

crop-area combinations considered in the analysis. With the exception of leaf crops grown in central Florida, potatoes produced in the Hastings area, and watermelons grown in the Immokalee-Lee area, the estimated annual productivity rates are quite low. In addition, only three of thirteen crop-area combinations considered exhibited statistically significant productivity growth rates. The predominately low R-square values, in combination with the low estimated-productivity growth rates and the lack of statistical precision indicate a general lack of productivity growth for the vegetable crops faced with only domestic competition.

Table 3 compares the rates of productivity growth for the crops considered in the present analysis and those for the crops analyzed by Taylor and Wilkowske (1984). Taylor and Wilkowske found substantial and statistically significant productivity growth for all the nine crop-area combinations they considered. In contrast, of the thirteen crop-area combinations analyzed in the present study only three exhibited somewhat significant productivity growth. Indeed the average rate of productivity growth for those crops which face import competition from Mexico was about 5.1 percent per year while the average rate of productivity for those crops which do not face import competition was about 1.6 percent per year.

It is interesting to note that the difference in productivity growth rates is insensitive to the method of calculating the average annual rate of growth. Even if weather effects are not accounted for, those crops that face considerable import competition had productivity growth rates that exceeded those in crops that faced limited domestic competition. The calculated differential in productivity growth using the arithmetic-, geometric- and endpoint-average methods discussed by Zohar and Luski indicated that the differences in average annual productivity growth between the two groups of crops were 3.4, 3.9 and 3.7 percent, respectively. The regression results implied the difference in productivity growth rates averaged about 3.5 percent per year.

CONCLUSIONS

In this paper, the relationship between competitive pressure and productivity growth was investigated in a case-study of the Florida fresh winter vegetable industry using 1969-1982 annual data. The empirical results provide fairly convincing evidence of the existence of a positive relationship between the level of competitive pressure and the rate of productivity growth. Those crops that faced significant pressure in the form of Mexican imports exhibited considerably higher rates of productivity growth than those crops that faced more limited domestic competition.

The Florida vegetable industry allows fairly well delineated groups of crops to be defined based on differential levels of competitive pressure and minimal government intervention. Thus, to a large extent, it is possible to isolate the relationship between productivity growth and competitive pressure. There remain, however, other factors that could be offered as potentially explaining the observed differences in productivity growth across the two sets of crops. Differences in the availability of improved technologies, the size of investments required for adoption, and the risk associated with it are also factors that could have influenced these rates of technical change and productivity growth. As to the availability of new technology, there is no evidence of developments which favored any one set of crops. In fact, as documented in *Florida Agriculture in the 80's: Vegetable Crops*, similar new technologies and cultural practices were available for most crops during the period of the analysis. Such new technologies included improved cultivars, utilization of plastic mulch, high density plantings, and new irrigation and pest control practices. The similarities in the nature of the available new technologies further suggest that no major differences existed in the size of initial investment requirements and the risks associated with their adoption. Hence, the availability of improved technologies, the size of initial investments required for adoption, and the risks in adopting the new technologies are not expected to have significantly influenced the productivity rates across the two sets of vegetable crops considered in this study.

Another factor that could modify the incentives for technical change across Florida vegetable crops is decreasing product demand manifested, at the firm level, through depressed real prices. Over the period of analysis, the average real f.o.b. price of those crops facing significant competitive pressure

Table 3. Average Annual Rates of Productivity Growth for Various Vegetable Crops. Crop Years: 1969-70 through 1981-82

Limited Competitive Pressure[a]			High Competitive Pressure[b]		
Crop	Area	Productivity Growth	Crop	Area	Productivity Growth
		(percent)			(percent)
Cabbage	Hastings	0.91	Cucumbers	Immokalee/Lee	4.77**
Celery	Central Florida	1.28	Peppers	Immokalee/Lee	6.61**
Celery	Everglades	0.38	Peppers	Palm Beach	8.32**
S. Corn	Central Florida	2.18*	Squash	Dade County	1.67**
S. Corn	Everglades	1.10	Squash	Immokalee/Lee	5.84**
S. Corn	Lower East Coast	2.99	Squash	Palm Beach	4.63**
Eggplant	Palm Beach	0.91	Tomatoes	Dade County	3.36**
Leaf Crops	Central Florida	4.78*	Tomatoes	Immokalee/Lee	4.81**
Leaf Crops	Everglades	-0.92	Tomatoes	Manatee/ Ruskin	5.59**
Potatoes	Dade County	0.67			
Potatoes	Hastings	5.06*			
Radishes	Everglades	-2.51			
Watermelon	Immokalee/Lee	4.38			

[a] Limited competitive pressure crops refer to those crops which faced only domestic competition.

[b] High competitive pressure crops refer to those crops which faced import competition. Annual productivity rates are reproduced from Taylor and Wilkowske (1984).

* Indicates statistical significance at the 95 percent level.

** Indicate statistical significance at the 99 percent level.

decreased by about 2.4 percent per year. In contrast, the average real prices for those crops facing limited competitive pressure increased at an average annual rate of 0.1 percent per year. Thus, there does not appear to be any evidence to suggest demand growth has played a major role in the observed differential in productivity growth across the two groups of crops.

Finally, some words of caution are necessary. First, the number of observations used to obtain the regression estimates was small and leads to questions concerning the statistical precision of the estimated parameters. Unfortunately, it was not possible to extend the data set to include more recent observations since the manner in which cost of vegetable production data were collected was changed from a survey format to technical budgeting in 1983, and the two series are incompatible.

Secondly, it should be emphasized that the results of this study are specific to the Florida fresh winter vegetable industry. In vegetable production, returns from technical change can be realized within a crop season and, in most cases, additional risks associated with technology adoption are small. Thus, the results of this study may not be generalized to production processes with high degrees of resource fixity for which technical change, usually, implies considerable additional risks and large initial capital investments. However, the findings of this analysis reinforce the need for further research so that the relationship between competitive pressure and productivity growth can be more fully assessed.

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