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

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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
light on the relationship between competitive pres-

sure 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 conten-

tion 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 assum-

ing 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 efficien-

cy; 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 fron-

tier 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 tech-

nical 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 re-

lated to technical change. In the agricultural tread-

mill 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 produc-
tion 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 pres-
ure 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 produc-
tivity 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 sig-
nificantly affect productivity growth. There is, how-
ever, a lack of agreement as to whether the degree 
of competitive pressure in any given market enhan-
ces 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 \( y_t = f(x_t; t) \) be a linearly homogeneous, concave twice differentiable and non-decreasing aggregate production function\(^1\), where \( x \) 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

\[
(1) \quad \text{TFP} = \frac{\dot{y}_t}{y_t} - \sum_i S_i \frac{x_{it}}{x_{it}}; \quad x_{it} = x_{1t}, \ldots, x_{kt},
\]

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 \( t = T \),

\[
\text{TFP} = \frac{\frac{y_T}{y_0}}{\sum_i S_i \int_0^T \frac{x_{it}}{x_{it}} dt}
\]

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 Tomqvist-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,

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

the Tomqvist-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:

\[
(4) \quad \text{TFP} = \frac{y_t}{y_0} \prod_i \left( \frac{x_{it}}{x_{i0}} \right)^{\frac{1}{2} (S_i - S_{i0})} (t = 0, 1, \ldots, T).
\]

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.

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\(^1\) 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:

\[
\frac{\text{TFP}_t}{\text{TFP}_0} = \ln \frac{y_t}{y_0} - \frac{1}{2} \sum_i \left( S_{it} + S_{i0} \right) \ln \frac{x_{it}}{x_{i0}}
\]

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

\[
\ln \text{TFP}_{it} = a_{oi} + a_{i1} T + a_{i2} D_i + U_{it}
\]

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

<table>
<thead>
<tr>
<th>Season</th>
<th>Celery</th>
<th>Cabbage</th>
<th>Sweet Corn</th>
<th>Eggplant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>East Coast</td>
<td>Florida</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Florida</td>
<td>Everglades</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hastings</td>
<td>Lower</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Central</td>
<td>Central</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Florida</td>
<td>Florida</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hastings</td>
<td>Palm Beach</td>
</tr>
<tr>
<td>1969-70</td>
<td>0.9590</td>
<td>0.8742</td>
<td>0.9103</td>
<td>0.4632</td>
</tr>
<tr>
<td>1970-71</td>
<td>1.1617</td>
<td>1.2426</td>
<td>0.9732</td>
<td>0.6025</td>
</tr>
<tr>
<td>1971-72</td>
<td>1.1011</td>
<td>1.4376</td>
<td>1.0915</td>
<td></td>
</tr>
<tr>
<td>1972-73</td>
<td>1.1401</td>
<td>1.0089</td>
<td>1.0551</td>
<td>0.8697</td>
</tr>
<tr>
<td>1973-74</td>
<td>1.0704</td>
<td>1.1227</td>
<td>1.1633</td>
<td>0.7638</td>
</tr>
<tr>
<td>1974-75</td>
<td>1.0416</td>
<td>1.4506</td>
<td>1.3717</td>
<td>0.9064</td>
</tr>
<tr>
<td>1975-76</td>
<td>1.2773</td>
<td>1.4836</td>
<td>1.5264</td>
<td>1.1053</td>
</tr>
<tr>
<td>1976-77</td>
<td>1.0221</td>
<td>1.1445</td>
<td>1.1323</td>
<td>0.6662</td>
</tr>
<tr>
<td>1977-78</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>1978-79</td>
<td>1.2018</td>
<td>1.1810</td>
<td>1.1290</td>
<td>0.9329</td>
</tr>
<tr>
<td>1979-80</td>
<td>1.1764</td>
<td>1.1309</td>
<td>0.9869</td>
<td>0.8630</td>
</tr>
<tr>
<td>1980-81</td>
<td>1.1543</td>
<td>1.2430</td>
<td>1.2184</td>
<td>0.9571</td>
</tr>
<tr>
<td>1981-82</td>
<td>1.0373</td>
<td>1.3675</td>
<td>1.1143</td>
<td>0.7395</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Season</th>
<th>Leaf Crops</th>
<th>Potatoes</th>
<th>Radishes</th>
<th>Watermelon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Central Florida</td>
<td>Everglades</td>
<td>Dade County</td>
<td>Hastings</td>
</tr>
<tr>
<td>1969-70</td>
<td>0.4822</td>
<td>1.2319</td>
<td>0.6662</td>
<td>0.8018</td>
</tr>
<tr>
<td>1970-71</td>
<td>0.5290</td>
<td>1.1188</td>
<td>0.6196</td>
<td>0.6996</td>
</tr>
<tr>
<td>1971-72</td>
<td>0.5319</td>
<td>0.9695</td>
<td>0.5742</td>
<td>0.6494</td>
</tr>
<tr>
<td>1972-73</td>
<td>0.6450</td>
<td>0.9426</td>
<td>0.8387</td>
<td>0.8708</td>
</tr>
<tr>
<td>1973-74</td>
<td>0.5439</td>
<td>0.8442</td>
<td>0.7711</td>
<td>0.6788</td>
</tr>
<tr>
<td>1974-75</td>
<td>0.8111</td>
<td>1.1308</td>
<td>0.9063</td>
<td>0.8919</td>
</tr>
<tr>
<td>1975-76</td>
<td>0.8627</td>
<td>1.1213</td>
<td>0.8883</td>
<td>1.0794</td>
</tr>
<tr>
<td>1976-77</td>
<td>0.8434</td>
<td>1.0648</td>
<td>0.5133</td>
<td>1.1564</td>
</tr>
<tr>
<td>1977-78</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>1978-79</td>
<td>0.8365</td>
<td>0.8838</td>
<td>0.7546</td>
<td>1.2731</td>
</tr>
<tr>
<td>1979-80</td>
<td>0.8365</td>
<td>1.0553</td>
<td>0.7023</td>
<td>1.0970</td>
</tr>
<tr>
<td>1980-81</td>
<td>0.9377</td>
<td>1.1409</td>
<td>0.6546</td>
<td>1.2152</td>
</tr>
<tr>
<td>1981-82</td>
<td>0.7597</td>
<td>0.8548</td>
<td>0.7006</td>
<td>1.1527</td>
</tr>
</tbody>
</table>

*Data not available

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 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 \( a_T = \frac{\partial \ln TFP_i}{\partial T} \) 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.
### Table 2. Estimated Regression Parameters for Various Vegetable Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area</th>
<th>Intercept</th>
<th>Trend</th>
<th>Dummy</th>
<th>R-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Hastings</td>
<td>0.4489</td>
<td>0.00918</td>
<td>—</td>
<td>0.07</td>
</tr>
<tr>
<td>Celery</td>
<td>Central FL</td>
<td>0.09702</td>
<td>0.01285</td>
<td>—</td>
<td>0.09</td>
</tr>
<tr>
<td>Celery</td>
<td>Everglades</td>
<td>0.06805</td>
<td>0.00388</td>
<td>—</td>
<td>0.03</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Central FL</td>
<td>-0.41764</td>
<td>0.02188</td>
<td>—</td>
<td>0.39</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Everglades</td>
<td>-0.03031</td>
<td>0.01107</td>
<td>—</td>
<td>0.15</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Lower East</td>
<td>-0.40742</td>
<td>0.02994</td>
<td>-0.19863</td>
<td>0.40</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Palm Beach</td>
<td>-0.13650</td>
<td>0.00912</td>
<td>—</td>
<td>0.11</td>
</tr>
<tr>
<td>Leaf Crops</td>
<td>Central FL</td>
<td>-0.67733</td>
<td>0.04786</td>
<td>—</td>
<td>0.58</td>
</tr>
<tr>
<td>Leaf Crops</td>
<td>Everglades</td>
<td>0.08478</td>
<td>-0.00918</td>
<td>—</td>
<td>0.08</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Dade County</td>
<td>-0.33624</td>
<td>0.00672</td>
<td>-0.38439</td>
<td>0.32</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Hastings</td>
<td>-0.41246</td>
<td>0.05061</td>
<td>—</td>
<td>0.71</td>
</tr>
<tr>
<td>Radishes</td>
<td>Everglades</td>
<td>0.41151</td>
<td>-0.02514</td>
<td>—</td>
<td>0.25</td>
</tr>
<tr>
<td>Watermelon</td>
<td>Immokalee Lee</td>
<td>-0.65603</td>
<td>0.04389</td>
<td>-0.79731</td>
<td>0.51</td>
</tr>
</tbody>
</table>

* 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 empiri-
cal 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

<table>
<thead>
<tr>
<th>Limited Competitive Pressure&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Productivity Growth</th>
<th>High Competitive Pressure&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Productivity Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop</strong></td>
<td><strong>Area</strong></td>
<td><strong>(percent)</strong></td>
<td><strong>Crop</strong></td>
</tr>
<tr>
<td>Cabbage</td>
<td>Hastings</td>
<td>0.91</td>
<td>Cucumbers</td>
</tr>
<tr>
<td>Celery</td>
<td>Central Florida</td>
<td>1.28</td>
<td>Peppers</td>
</tr>
<tr>
<td>Celery</td>
<td>Everglades</td>
<td>0.38</td>
<td>Peppers</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Central Florida</td>
<td>2.18*</td>
<td>Squash</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Everglades</td>
<td>1.10</td>
<td>Squash</td>
</tr>
<tr>
<td>S. Corn</td>
<td>Lower East Coast</td>
<td>2.99</td>
<td>Squash</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Palm Beach</td>
<td>0.91</td>
<td>Tomatoes</td>
</tr>
<tr>
<td>Leaf Crops</td>
<td>Central Florida</td>
<td>4.78*</td>
<td>Tomatoes</td>
</tr>
<tr>
<td>Leaf Crops</td>
<td>Everglades</td>
<td>-0.92</td>
<td>Tomatoes</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Dade County</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>Hastings</td>
<td>5.06</td>
<td></td>
</tr>
<tr>
<td>Radishes</td>
<td>Everglades</td>
<td>-2.51</td>
<td></td>
</tr>
<tr>
<td>Watermelon</td>
<td>Immokalee/Lee</td>
<td>4.38</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Limited competitive pressure crops refer to those crops which faced only domestic competition.

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

<sup>*</sup> Indicates statistical significance at the 95 percent level.

<sup>**</sup> 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.

REFERENCES


