The Impact of Huanglongbing (HLB) on Citrus Tree Planting in Florida

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Introduction

Huanglongbing (HLB) is a bacterial disease of citrus that until recently was confined to Asia and Africa. In 2005, the disease was first discovered in Florida. Since then, it has spread rapidly and now can be found in all counties in the state that contain commercially produced citrus. HLB represents one of the strongest threats to largest citrus producing state in the United States. In the 2007-08 season, Hodges and Rahmani (2009) estimated that the economic impact of the citrus industry on the economy of Florida was $8.9 billion.

HLB affects citrus trees by blocking the phloem or the vascular system of the tree limiting its ability to uptake nutrients. It is spread by a small leaf-feeding insect: the Asiatic Citrus Psyllid (ACP). The characteristics of the disease are mottled leaves and small misshapen fruit. Large fruit drop is associated with the disease, but even if fruit remains on the tree until harvest, the fruit is undersized and contain bitter juice rendering it of no economic value.

Two approaches have evolved to combat the disease. The first approach is generally credited to Bové, who is also credited with first identifying the disease. In the Bové approach, an aggressive scouting program is initiated. Any tree found that exhibits symptoms of HLB is immediately eradicated. A program to suppress the ACP population is also initiated.

The Achilles' heel of the Bové program is that infected trees may not exhibit symptoms for up to two years (in the case of mature trees) after becoming infected. Thus, eradicating only symptomatic trees will not eliminate the disease. Diligent implementation of this approach should suppress the level of disease inoculum so that annual tree losses are economically tolerable. Another disadvantage of this approach is the so-called "bad neighbor" effect. If a single grower among a contiguous planting fails to follow the Bové approach, their grove will continue to serve as a source of inoculum. Another issue is that if the level of infection is too high before the disease is discovered, it may be necessary to eradicate an entire block.

University of Florida economists have estimated that the Bové method increases per acre grove maintenance costs by approximately $400 annually, an increase of 33 percent (Muraro). As bearing tree numbers decrease, per acre yields will also decrease.

A grower in southwest Florida, faced with a high of level of infection, decided to implement another approach to deal with HLB. Since HLB blocks the phloem of citrus trees, he devised an approach of feeding trees through their leaves, thereby by-passing the phloem. This approach is known as enhanced foliar nutrition. Under this approach, scouting for the disease is halted, and symptomatic trees are not eradicated. This approach has shown some success in masking the effects of the disease enabling trees to produces significant volumes of fruit. It elevates the cost of grove maintenance ranging from $200 to $600 per acre.

The purpose of this paper is to examine the impact of the presence of HLB on new tree plantings in the Florida citrus industry. Sweet oranges are by far the most important citrus scion grown in Florida so the analysis is limited to sweet orange plantings. As HLB impacts citrus through reduced yield, increased mortality, and increased cost of production, it is expected that the presence of HLB has had an adverse impact of growers' willingness to invest in new trees.

Theoretical Considerations

Citrus growers adjust output through investment in new plantings. The economics of new grove investment in citrus has been previous studied by several authors including

Kalaitzandonakes and Shonkwiler (1992), and Spreen, et al. (2003). In both of these studies, new citrus tree plantings were found to be (1) related to past prices and (2) highly autoregressive. In this paper, a hybrid model that follows along the line of both Kalaitzandonakes and Shonkwiler, and Spreen, et al. is utilized in which new plantings in period t, denoted by NP_t, is modeled as a function of past plantings, NP_{t-1}, and lagged grower prices, P_{t-1}. Grove maintenance costs, C_t, as compiled by the University of Florida on an annual basis will also be included as an explanatory variable. In a linear specification, this model is

$$NP_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 NP_{t-1} + \beta_3 C_{t-1} + \beta_4 HLB_t + \varepsilon_t \qquad (1)$$

To account for the effect of HLB on new tree plantings, a dummy variable approach is used. This variable (HLB) takes on the value 1 for years after 2006-07, and zero otherwise. If the presence of HLB has had an adverse effect on plantings, it is expected that the parameter on this variable will be statistically significant with a negative sign.

Data

Data on new plantings of round oranges disaggregated into early and mid-season maturing (early-mid) and Valencia (late season) varieties is reported by the Florida Agricultural Statistics Service (FASS). Grower (on-tree) prices also disaggregated into early-mid and Valencia varieties are also reported. For this analysis, the data covers the period extending from the 1989-90 through the 2010-11 season. The decade of the 1980s saw several freezes visit the citrus region of Florida, which spurred a massive replanting and therefore was excluded from this analysis.

Grove maintenance costs for Florida citrus is compiled annually by Muraro and associates. This data was assembled for the same time interval, 1989-90 through 2010-11.

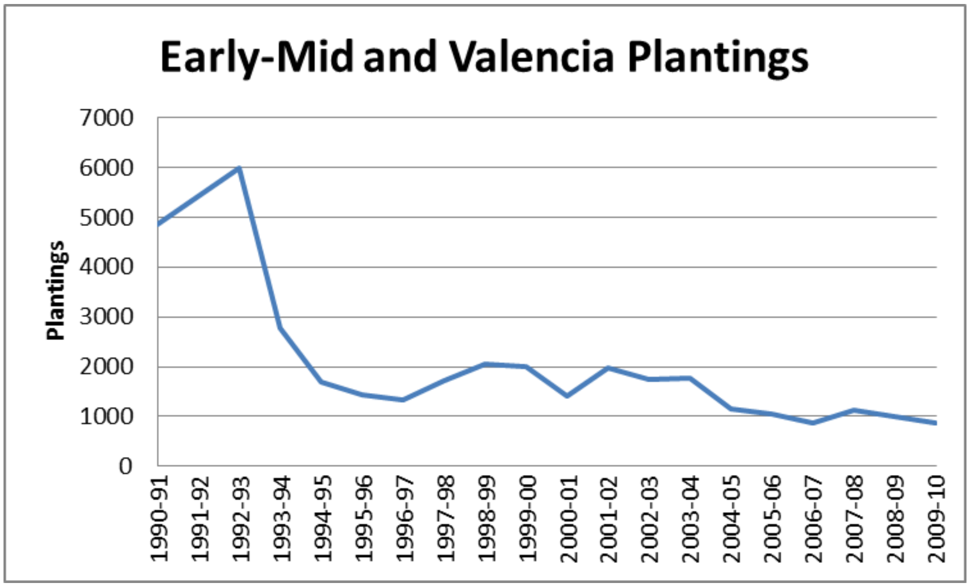

Figure 1: Total Tree Plantings (1990 – 2010)

In Figure 1, total orange tree plantings in Florida are plotted over the sample period. The high level of plantings in the early 1990s was in response to high grower prices associated with reduced supply of juice oranges after the freezes of the 1980s. As grower prices declined in the latter portion of the 1990s, so did new tree plantings. Hurricanes visited the citrus growing area both 2004-05 and 2005-06. Reduced supply of oranges caused prices to rise, but note the failure of new plantings to respond to higher prices.

Statistical Analysis

The model (1) presents new plantings in time period *t* as a function of price, new plantings, and cost in period *t-1,* as well as a dummy variable that indicates the presence of HLB in period *t.* Lagged new plantings is included to account for the presence of probable serial correlation occurrences within time series models. Disaggregating new plantings into early-mid and Valencia varieties, two separate regression models are estimated with their explanatory variables corresponding to the specific variety. Cost was introduced as an explanatory variable in predicting new plantings; however, preliminary results indicate insignificant explanatory power of this variable and, as a consequence, the variable was removed from the analysis.

Parameter estimates and associated statistics for the model are shown in Table 1. For each model, the inclusion of new plantings and grower prices is seen as highly significant. The positive parameters associated with these variables imply that, everything else equal, an increase in previous years' planting and prices result in increased new plantings. This is consistent with *a priori* expectations based on previous observations. The dummy variable (HLB) is significant within both early-mid and Valencia models, attaining levels of significance within 95% and 90% respectively. The negative significance of the parameter provides evidence in explaining the expected adverse effect of HLB on willingness to invest in new trees.

Table 1: Regression Results for Early-Mid and Valencia New Plantings.

	Early-Mid	Valencia
Constant	-334.8273 (306.1506)	-404.2493 (298.6336)
Lagged New Plantings	0.5658283*** (0.1558799)	0.6897042*** (0.111694)
Grower Prices	210.5084** (88.61119)	142.9528** (63.52688)
HLB	-779.092** (365.9027)	-585.1652* (322.3179)
R-squared	0.6992	0.8329
Adjusted R-squared	0.6390	0.7995
No. observations	19	19

Standard errors are reported in parentheses.
*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.

A striking result of the regression results is the magnitude of the estimated coefficient on the HLB dummy variable in both the early-mid and Valencia new planting equations. The coefficient in the early-mid equation is -779.02 which suggests that each year, the presence of HLB reduces new plantings of early and mid-maturing varieties by 779,000 trees. In 2011 approximately 550,000 early-mid trees were planted. Therefore the HLB effect reduced potential new plantings by more than 50 percent. The coefficient of the HLB dummy variable in Valencia equation is -585.16; the estimated number of Valencia new tree plantings in 2011 was approximately 490,000. Again, effect reduced potential new plantings by more than 50 percent.

Implications of the Regression Results

Using the world orange juice model first developed by McClain (1989) and later modified by Spreen, et al. (2003) and Spreen and Jauregui (2009), the implications of the negative effect of the presence of HLB on future orange production in Florida can be simulated.

The world orange juice model is a spatial equilibrium model of the world orange juice market. It includes Florida and Sao Paulo, Brazil who collectively account for over 80 percent of world orange juice supply as endogenous supply regions. Production from Mexico, California, and Central America (Belize and Costa Rica) is included at fixed levels. Demand regions include the United States, the European Union, Canada, and the rest of the world. In the United States and Canada, demand is disaggregated into not-from-concentrate (NFC) and from concentrate consumption (FCOJ).

Using the tree inventory complied for Florida and Sao Paulo, orange production is generated. A fixed amount is deducted to account for fresh orange utilization, and the remainder is converted to orange juice using historical juice yield data. This juice is allocated across the four regional markets and across NFC and FCOJ via a mathematical programming model. See

Spreen, et al. (2003) for the details of the model. Once a spatial and product form equilibrium has been established, prices in each of the demand markets are determined. Adjusting for tariffs (if any), transportation, processing, and harvest costs, grower (on-tree) prices are determined. These prices are then used as input into a new planting equation. The tree inventory is aged and adjusted for tree mortality and the model is solved again for the following season.

The model has been validated for the 2011-12 marketing year. It is then run under two scenarios: with the HLB dummy variable in the new planting equation and without the HLB dummy variable. The results are summarized in Figures 2 and 3.

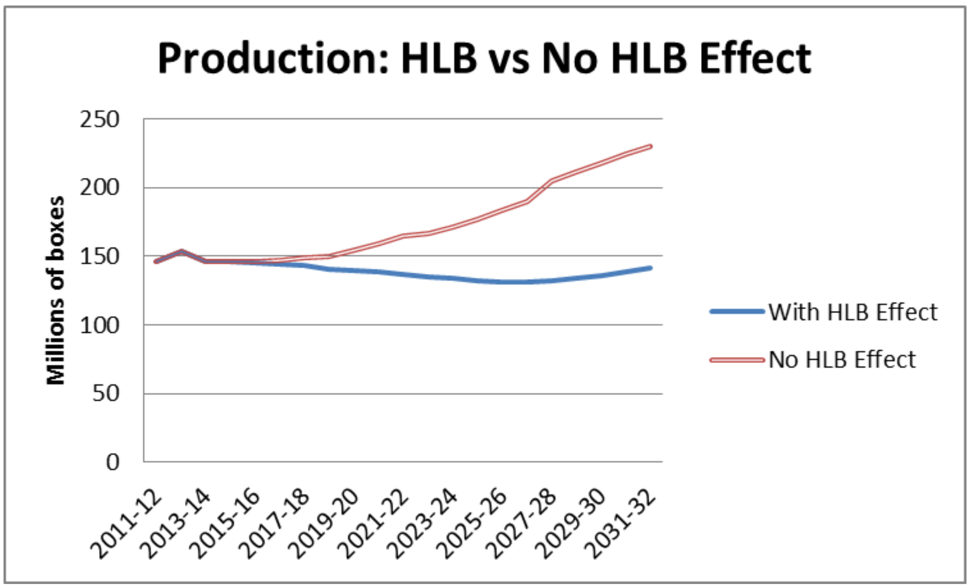

Figure 2: Projected Production (millions of boxes)

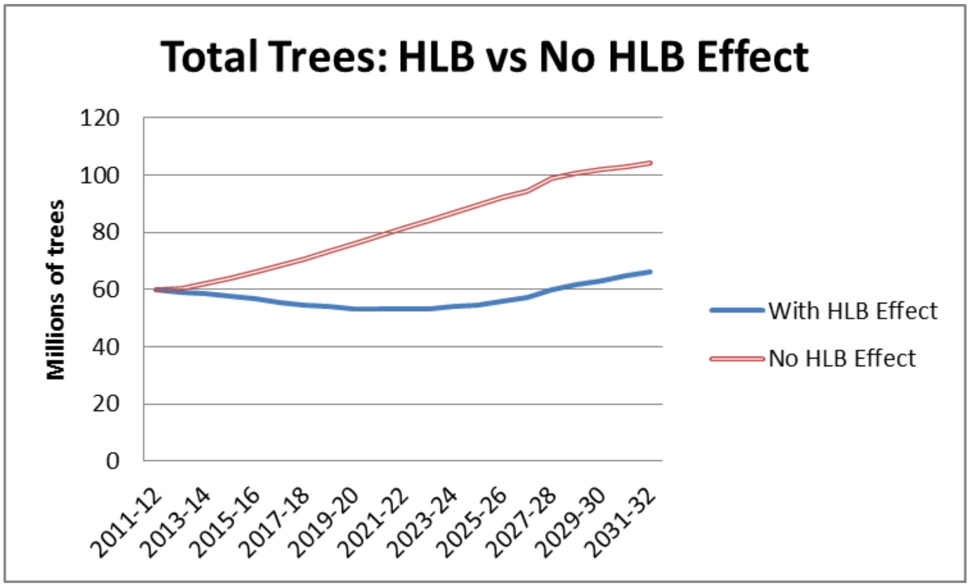

Figure 3: Projected Total Trees (millions)

In Figure 2, projected Florida orange production in millions of 90 pound boxes is shown over the 2011-12 to 2031-32 period. With the HLB effect on new plantings included, sweet orange production is expected to diminish slightly over the next 10 seasons and then in response to higher prices, recover to almost 150 million boxes. In the 2011-12 season, actual production was 146.5 million boxes. If the HLB effect is deleted, production is projected to remain relatively flat for the next five seasons, and then rise reaching approximately 225 million boxes by 2031-32. The data shown in Figure 3 support these observations; tree numbers remain relatively flat with HLB and exhibit a strong recovery without HLB.

This analysis assumes that no solution to HLB will be discovered within the next 20 years. Given the research dollars that are being allocated to finding solutions to HLB, it is likely that some sort of HLB mitigating strategy will be found. This might be a disease resistant tree, better control of the ACP, or antibiotic that can suppress the disease.

HLB is also found in Sao Paulo, Brazil, and this study ignores the HLB impact there. For the most part, Sao Paulo has followed the Bové approach of aggressively scouting and eradicating symptomatic trees. This has been incorporated in the world orange juice model by increasing tree mortality rates. If a solution to HLB is discovered, that solution will also likely be used in Sao Paulo and thereby affecting the assumptions of the model.

Concluding Remarks

Huanglongbing (HLB) is a relatively new disease to the Florida citrus industry. The industry appears to have adopted a foliar nutrition approach in attempt to mitigate the effects of the disease. The consequences of HLB are higher tree mortality, reduced yields, and higher grove maintenance costs all of which have negative impacts on grove profitability. A causal examination of new plantings in Florida suggests the presence of HLB has reduced the willingness of Florida growers to invest in new plantings.

Two new tree planting equations were estimated for Florida sweet oranges: early and mid-maturing varieties and Valencias using data that spanned the period 1989-90 through 2010-11. Previous studies suggested that new plantings are a function of grower (on-tree) prices and lagged plantings. Grove maintenance costs were also collected and included in the regression equation, but proved to not be a useful explanatory variable. To account for the possible impact of HLB, a dummy variable approach was used. The estimated coefficients for grower prices and lagged prices were statistically significant and of the correct sign. The estimated coefficient for the HLB variable was negative and quite large in magnitude although it was statistically significant at the 90 percent level for Valencias.

The estimated new planting equations were incorporated into the world orange juice model developed at the University of Florida. Simulations were produced for the period 2011-12 through 2031-32 in which the HLB effect was both included and excluded. As expected, these two simulations produced quite different projections for both future orange production and tree numbers in Florida. With HLB, Florida orange production is expected to remain at current levels of approximately 150 million boxes; without HLB, Florida orange production is projected to increase to nearly 225 million boxes by 2031-32.

The results presented herein provide one measure of the adverse impact that HLB is imposing on the Florida citrus industry. The disease also has other dimensions of impact and continues to threaten the future viability of the Florida citrus.

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