THE IMPACT OF TWO-RATE TAXES
ON CONSTRUCTION IN PENNSYLVANIA

by

Florenz Plassmann

Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Economics

Approved:

______________________ _____________________
T.N. Tideman, Chairman

______________________  ______________________
R. Ashley                J. Christman

______________________  ______________________
C. Michalopoulos        S. Snyder

June 24, 1997
Blacksburg, Virginia
THE IMPACT OF TWO-RATE TAXES ON CONSTRUCTION IN PENNSYLVANIA

by

Florenz Plassmann

T. Nicolaus Tideman, Chairman

Department of Economics,
Virginia Polytechnic Institute and State University

(ABSTRACT)

The evaluation of policy-relevant economic research requires an ethical foundation. Classical liberal theory provides the requisite foundation for this dissertation, which uses various econometric tools to estimate the effects of shifting some of the property tax from buildings to land in 15 cities in Pennsylvania. Economic theory predicts that such a shift will lead to higher building activity. However, this prediction has been supported little by empirical evidence so far.

The first part of the dissertation examines the effect of the land-building tax differential on the number of building permits that were issued in 219 municipalities in Pennsylvania between 1972 and 1994. For such count data a conventional analysis based on a continuous distribution leads to incorrect results; a discrete maximum likelihood analysis with a negative binomial distribution is more appropriate. Two models, a non-linear and a fixed effects model, are developed to examine the influence of the tax differential. Both models suggest that this influence is positive, albeit not statistically significant.

Application of maximum likelihood techniques is computationally cumbersome if the assumed distribution of the data cannot be written in closed form. The negative binomial distribution is the only discrete distribution with a variance that is larger than its mean that can easily be applied, although it might not be the best approximation of the true distribution of the data. The second part of the dissertation uses a Markov Chain Monte Carlo method to examine the influence of the tax differential on the number of building permits, under the assumption that building permits are generated by a Poisson process whose parameter varies lognormally. Contrary to the analysis in the first part, the tax is shown to have a strong and significantly positive impact on the number of permits.

The third part of the dissertation uses a fixed-effects weighted least squares method to estimate the effect of the tax differential on the value per building permit. The tax coefficient is not significantly different from zero. Still, the overall impact of the tax differential on the total value of construction is shown to be positive and statistically significant.
ACKNOWLEDGEMENTS:

I express my gratitude to

Edelgard and Florenz IV. Plassmann, my parents,
without whom I would never have started.

T. Nicolaus Tideman, my advisor,
without whom I would never have continued.

Vandana, my wife,
without whom I would never have finished.
TABLE OF CONTENTS:

Abstract ............................................................................................................................ ii

Acknowledgements ........................................................................................................... iii

List of figures ..................................................................................................................... vii

List of tables ...................................................................................................................... viii

Chapter 1: Motivation

1.1 Introduction .................................................................................................................. 1
1.2 Normative economics .................................................................................................. 3
1.3 Liberalism ...................................................................................................................... 9
1.4 Neoclassical economics and liberalism ........................................................................ 13
1.5 Public collection of rent .............................................................................................. 16
1.6 Plan of the study .......................................................................................................... 19

Chapter 2: Land Value Taxation

2.1 Introduction .................................................................................................................. 22
2.2 Economic theory of land value taxation ...................................................................... 23
2.3 Application of land value taxation .............................................................................. 26
   2.3.1 Land value taxation outside the United States ...................................................... 26
   2.3.2 Land value taxation in the United States ............................................................. 29
       2.3.2.1 History of land value taxation in the United States ......................................... 29
       2.3.2.2 History of land value taxation in Pennsylvania ............................................. 31
       2.3.2.3 Empirical work on land value taxation in Pennsylvania ............................. 32

Chapter 3: Estimation Techniques

3.1 The analysis of count data ............................................................................................ 40
3.2 Poisson models ............................................................................................................ 42
3.3 Negative binomial models ........................................................................................... 45
   3.3.1 Standard derivation and specification .................................................................. 45
   3.3.2 Alternative derivation ......................................................................................... 48
   3.3.3 Alternative specification ...................................................................................... 50
3.4 Markov Chain Monte Carlo methods .......................................................................... 53
Chapter 4: Setup of the Analysis and Preliminary Data Examination

4.1 Introduction ................................................................. 58
4.2 Review of the data: The Bureau of the Census data collection ............ 58
4.3 Municipalities used in the study ...................................... 62
4.4 Construction of demographic data ..................................... 65
4.5 The dependent variables ............................................ 66
4.6 The independent variables ........................................... 67
4.7 Data analysis with OLS and the Tobit model ............................ 69
4.8 Data analysis with the Poisson and the negative binomial model ............. 71
4.9 Conclusion ................................................................. 74

Chapter 5: Analysis of ‘Number of Permits’ with Maximum Likelihood

5.1 Introduction ................................................................. 75
5.2 The relationship between the mean and the variance ...................... 75
5.3 Correction for serial correlation ....................................... 77
5.4 A non-linear model ................................................ 78
  5.4.1 Setup of the model ........................................... 78
  5.4.2 Examination of nonresidential construction of whole units ............ 81
  5.4.3 Examination of residential construction of whole units ............... 90
5.5 A fixed effects model .............................................. 92
  5.5.1 Setup of the model ........................................... 92
  5.5.2 Serial correlation ............................................ 93
  5.5.3 The different models and their estimates ......................... 96

Chapter 6: Analysis of ‘Number of Permits’ with the Gibbs Sampler

6.1 Introduction ................................................................. 100
6.2 Setup of the model ................................................ 100
6.3 Estimation of the model ............................................ 104
6.4 Results ................................................................. 105

Chapter 7: Analysis of ‘Value per Permit’

7.1 Introduction ................................................................. 109
7.2 Setup of the model ................................................ 109
7.3 Estimation, refinements, and results of the model ......................... 111
7.4 Conclusion ................................................................. 117
Chapter 8: Conclusion

8.1 Summary and evaluation of the study ........................................ 118
8.2 Deficiencies of the analysis and suggestions for further research .......... 123
8.3 Conclusion .................................................................................. 125

Appendix A: Number of Building Permits in the Two-Rate Cities
Between 1980 and 1994 ................................................................. 127

Appendix B: Value per Permit in the Two-Rate Cities
Between 1980 and 1994 ................................................................. 131

Appendix C: Number of Months for which Data are available for the
Two-Rate Cities Between 1980 and 1994 ............................. 135

Appendix D: Building Permits Survey Documentation:
Description of Data Items ...................................................... 136

Appendix E: Histograms of the Distribution of ‘Number of Permits’ ....... 139

Appendix F: Alternative Distribution for the Maximum
Likelihood Analysis ................................................................. 146

Appendix G: Full Conditional Distributions for the Gibbs Sampler ....... 147

References ...................................................................................... 151

Vita ................................................................................................. 164
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Cities with two-rate taxes between 1980 and 1994</td>
<td>34</td>
</tr>
<tr>
<td>3.1</td>
<td>Relationship between the mean and the coefficient of variation</td>
<td>50</td>
</tr>
<tr>
<td>3.2</td>
<td>Monte Carlo integration</td>
<td>55</td>
</tr>
<tr>
<td>4.1</td>
<td>Distribution of population densities in 1980</td>
<td>64</td>
</tr>
<tr>
<td>4.2</td>
<td>Distribution of population change during the 1970s</td>
<td>64</td>
</tr>
<tr>
<td>4.3</td>
<td>Distribution of income in 1980</td>
<td>64</td>
</tr>
<tr>
<td>5.1</td>
<td>Relationship between the actual excess CV and μ</td>
<td>76</td>
</tr>
<tr>
<td>5.2</td>
<td>Relationship between Density and the first derivative of the intercept for various functional relationships</td>
<td>82</td>
</tr>
<tr>
<td>5.3</td>
<td>Relationship between Density and the first derivative of the intercept once density is included as a parabola</td>
<td>84</td>
</tr>
<tr>
<td>5.4</td>
<td>Relationship between Income and the first derivative of the intercept for various functional relationships</td>
<td>84</td>
</tr>
<tr>
<td>5.5</td>
<td>Relationship between Lagged Population Change and the first derivative of the intercept when Lagged Population Change is not included in the analysis</td>
<td>86</td>
</tr>
<tr>
<td>5.6</td>
<td>Relationship between the First Lagged Residual and the first derivative of the intercept for various functional relationships</td>
<td>87</td>
</tr>
<tr>
<td>6.1</td>
<td>Graphical model for the number of building permits</td>
<td>102</td>
</tr>
<tr>
<td>6.2</td>
<td>Residential construction of whole units</td>
<td>106</td>
</tr>
<tr>
<td>6.3</td>
<td>Residential additions and alterations</td>
<td>106</td>
</tr>
<tr>
<td>6.4</td>
<td>Nonresidential construction of whole units</td>
<td>107</td>
</tr>
<tr>
<td>6.5</td>
<td>Nonresidential additions and alterations</td>
<td>107</td>
</tr>
<tr>
<td>7.1</td>
<td>Relationship between ln(buildings) and the residuals in the OLS regression</td>
<td>114</td>
</tr>
<tr>
<td>7.2</td>
<td>Relationship between ln(buildings) and the weighted residuals in the weighted least squares regression</td>
<td>114</td>
</tr>
<tr>
<td>E.1</td>
<td>Histograms of the number of permits</td>
<td>139</td>
</tr>
</tbody>
</table>
# List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Summary of previous OLS studies of two-rate taxes in Pennsylvania</td>
<td>38</td>
</tr>
<tr>
<td>4.1</td>
<td>The different categories in the Bureau of the Census data set</td>
<td>60</td>
</tr>
<tr>
<td>4.2</td>
<td>Estimation results of models that assume a continuous distribution</td>
<td>69</td>
</tr>
<tr>
<td>4.3</td>
<td>Estimation results of the Poisson model</td>
<td>71</td>
</tr>
<tr>
<td>4.4</td>
<td>Estimation results of overdispersion tests</td>
<td>72</td>
</tr>
<tr>
<td>4.5</td>
<td>Estimation results of the negative binomial model</td>
<td>73</td>
</tr>
<tr>
<td>5.1</td>
<td>Nonresidential construction of whole units</td>
<td>89</td>
</tr>
<tr>
<td>5.2</td>
<td>Residential construction of whole units</td>
<td>91</td>
</tr>
<tr>
<td>5.3</td>
<td>Nonresidential construction of whole units and additions and alterations</td>
<td>97</td>
</tr>
<tr>
<td>5.4</td>
<td>Residential construction of whole units and additions and alterations</td>
<td>98</td>
</tr>
<tr>
<td>6.1</td>
<td>Model specification</td>
<td>103</td>
</tr>
<tr>
<td>6.2</td>
<td>Estimation results</td>
<td>108</td>
</tr>
<tr>
<td>7.1</td>
<td>Estimation results with OLS and weighted least squares</td>
<td>112</td>
</tr>
<tr>
<td>7.2</td>
<td>Estimation results of the weighted least squares fixed effects model</td>
<td>116</td>
</tr>
<tr>
<td>8.1</td>
<td>Summary of all estimates of the tax coefficient</td>
<td>119</td>
</tr>
<tr>
<td>8.2</td>
<td>Estimated increase in Pittsburgh’s construction after a 1 percentage point increase in the tax differential, and after a switch to a land-only tax</td>
<td>121</td>
</tr>
<tr>
<td>A.1</td>
<td>Number of building permits in the two-rate cities between 1980 and 1994</td>
<td>127</td>
</tr>
<tr>
<td>B.1</td>
<td>Value per building permit in the two-rate cities between 1980 and 1994</td>
<td>131</td>
</tr>
<tr>
<td>C.1</td>
<td>Number of Months reported for the two-rate cities between 1980 and 1994</td>
<td>135</td>
</tr>
</tbody>
</table>