

CHAPTER 8

Conclusion

8.1 Summary and evaluation of the study

The results of the study are summarized in Table 8.1.¹⁸⁰ The upper part of the table, which shows the analysis of the number of permits, indicates the great influence that distributional assumptions have on the analysis of the number of building permits. The Poisson model showed a significant impact of the tax differential in three of the four data sets. Yet the overdispersion tests in Section 4.8 revealed that the assumption of equal mean and variance that is made by the Poisson distribution is not justified for any of the data sets. In addition, the estimated negative impact on the tax differential on nonresidential construction of whole units does not make any economic sense; this is a further indication that the model was misspecified. The negative binomial distribution can be used to describe data with overdispersion, and was therefore employed in the following analysis. However, the linear analysis in Section 4.8 made too many restrictive assumptions about the form of heteroskedasticity among the observations and about the relationships among the variables to yield convincing results. The nonlinear analysis in Section 5.4 used a more appropriate model of heteroskedasticity, and did not rely on the assumption of a linear relationship among the variables. Surprisingly, it showed a statistically significant negative impact on nonresidential construction. Yet it is likely that this model omitted too many explanatory determinants to give a satisfactory description of the determinants of construction, and that the tax variable actually measures the effect of something else. As it can be interpreted as a dummy variable for the two-rate cities, which are all in economic distress, the negative effect might rather represent the economic condition than the impact of the two-rate tax. A fixed effects analysis with a dummy variable for each municipality can overcome this difficulty. The fixed effects models in Section 5.5 used all information that was gained during the analysis so far, but did not yield statistically significant results for the tax coefficient, although all coefficients had the expected sign.

¹⁸⁰ The intervals below the coefficients indicate 95 percent confidence intervals for the value of the coefficient for the respective models. They are not completely accurate because they are calculated under the assumption of normality, and the maximum likelihood estimates of the standard errors are only asymptotically efficient. Yet the assumption of asymptotic normality does not seem too far fetched, and the intervals provide some help in interpreting the results.

Table 8.1 Summary of all estimates of the tax coefficient

Analysis of	Model	Section	Residential Whole Units	Residential Additions & Alterations	Nonresidential Whole Units	Nonresidential Additions & Alterations
Number of permits	Poisson	4.8	-0.04713 [-0.184, 0.089]	0.22377 [0.187, 0.261]	-0.0999 [-0.141, -0.059]	0.19524 [0.120, 0.271]
		4.8	-0.12153 [-0.257, 0.014]	-0.05829 [-0.240, 0.124]	-0.002049 [-0.138, 0.134]	-0.09644 [-0.337, 0.144]
	Negative Binomial	5.4	-0.0251 [-0.149, 0.099]	-	-0.0665 [-0.086, -0.047]	-
		5.5	0.0682 [-0.72, 0.208]	0.0582 [-0.166, 0.282]	-0.0591 [-0.282, 0.164]	0.0706 [-0.149, 0.290]
Value per permit	Gibbs Sampler (fixed effects model)	6.3	0.1508 [0.135, 0.167]	0.1419 [0.129, 0.155]	0.0481 [-0.015, 0.111]	0.3948 [0.362, 0.428]
		7.3	0.0284 [-0.015, 0.072]	0.0942 [0.044, 0.145]	0.3121 [0.198, 0.426]	0.2685 [0.172, 0.365]
	7.3	-0.0086 [-0.075, 0.058]	-0.0132 [-0.080, 0.054]	0.0649 [-0.078, 0.208]	-0.0688 [-0.225, 0.087]	
Total Value	Calculated from the results in 6.3 and 7.3	8.1	0.1422 [0.074, 0.210]	0.1287 [0.060, 0.197]	0.1130 [-0.044, 0.270]	0.3260 [0.166, 0.486]

- Notes:
1. Results of the preliminary OLS, fixed effects and Tobit analyses in Section 4.7 are not shown, because these models make assumptions that do not hold for the data.
 2. The data sets with residential and nonresidential additions and alterations were not examined with the nonlinear model in Section 5.4.
 3. The intervals underneath the coefficients are estimated 95 percent confidence intervals.

The assumption that the number of permits follow a negative binomial distribution is not necessarily valid, and is made primarily for computational ease. Recognizing this led to the Gibbs Sampler analysis in Chapter 6, which used a fixed effects model in the context of a mixture of a Poisson and lognormal prior distributions. In this analysis all tax parameters have the expected sign, and all are highly statistically significant with the exception of the analysis of construction of nonresidential whole units.

For the construction of whole residential units, the estimated coefficient is 0.1508, and accepting the validity of the very flat prior distribution, the true value of the coefficient is between 0.135 and 0.167 with a probability of 95 percent.¹⁸¹ How can this result be interpreted, and what are the conclusions for any of the two-rate cities, for example, for Pittsburgh? The functional relationship between the expected number of building permits μ and the value of the tax differential τ was assumed to be

$$\ln(\mu) = \alpha + S + Y + \tau TAX + \ln(POP) + \ln(MON) \quad (8.1)$$

where α is an intercept term, S represents the economic status of the municipality, Y shows the impact of macroeconomic conditions that change from year to year, POP is population and MON is the number of months for which construction shall be predicted. Between 1980 and 1994, Pittsburgh had an average number of residential building permits of 314, which translates to $\ln(\mu) = 5.7494$. Pittsburgh's current tax differential is 152.5 mills, and the assessment ratio is 20.28 percent, which results in an adjusted tax differential of 3.0933 percent. An increase in the tax differential of 1 percentage point would yield an adjusted tax differential of 3.2955 percent, and, *ceteris paribus*, an increase in $\ln(\mu)$ of 0.0306, which translates into an additional 9.8 residential buildings per year. The estimated increase in the number of building permits that will result from a 1 percentage point increase in the tax differential is shown in Table 8.2 for all four categories of construction.

Another interesting question is, how construction has been affected by Pittsburgh's switch to the two-rate tax. The second column from the bottom in Table 8.2 shows the estimated increase in construction that has been caused by the two-rate tax. Finally, it is informative to ask what would happen, if Pittsburgh decided to switch to a land-only tax, that is, if the tax on structures was abolished. The last two rows in Table 8.2 show the estimated impact on construction of a revenue-neutral switch to a land-only tax. The results for residential construction seem reliable, while the result for nonresidential additions and alterations seems to be too high. This raises the question of whether such a large extrapolation of the logarithmic functional form is possible.

¹⁸¹ Because the Gibbs Sampler yielded a sample of 3,000 draws, a 95 percent confidence interval can be calculated by determining the value of the 75th and the 2925th draw of the ordered sample.

Table 8.2 Estimated increase in Pittsburgh’s annual construction after a 1 percentage point increase in the adjusted tax differential, and after a switch to a land-only tax

		Residential Whole Units	Residential Additions & Alterations	Nonresidential Whole Units	Nonresidential Additions & Alterations
Mean number of permits 1980-1994		314.0	2299.1	27.27	976.8
Marginal impact of the two-rate tax					
1 percentage point increase in the adjusted city tax differential	Estimated increase in the number of permits	9.8	67.1	0.27	81.42
	95 percent confidence interval	[8.7 , 10.8]	[60.9 , 73.3]	[-.08 , 0.6]	[74.3 , 88.6]
Extrapolated impact of the two-rate tax					
Improvement compared to a one-rate tax (city only)	Estimated increase in the number of permits	116.0	808.09	3.17	684.4
	95 percent confidence interval	[106 , 125]	[757 , 865]	[-1.2 , 7.6]	[656.7 , 716.3]
Improvement if Pittsburgh switched to a land-only tax	Estimated increase in the number of permits	235.0	1,573.8	4.4	3,198.6
	95 percent confidence interval	[203 , 268]	[1,421 , 1,762]	[-1.3 , 13.0]	[2,788 , 3820]

Note: The 95 percent confidence interval is calculated from the estimated confidence interval in Table 8.1.

The analysis of value per permit is summarized in the second part of Table 8.1. In the weighted least squares analysis with four explanatory variables, the tax coefficient was found to be always positive, and to have a significant impact in three of the four data sets. Yet as before, the analysis suffers from the lack of detailed information about the determinants of construction, which can be seen from the low R^2 , and from the fact that the introduction of municipality dummies increases the explanatory power by enough to justify the use of the additional 210 - 214 dummy variables. None of the tax coefficients in the fixed effects model is significant. Histograms of the error terms of this model (not included in this dissertation) show that the assumption of a normally distributed error is justified for these data, so that the least squares analysis is warranted.

The question that was posed in Chapter 2, and which is examined by other studies, concerns the impact of the two-rate tax on the total value of construction. For any category of construction, the percentage increase in the value of construction that results from a 1 percentage point increase in the adjusted tax differential can now be calculated as the sum of the estimates of the percentage increases in the 'Number of Building Permits' in Section 6.4 and the estimates of the percentage increases in 'Value per Permit' in Section 7.3. The results are shown in the last row in Table 8.1. The estimated impact is similar for all four data sets; especially when the standard error of estimate is considered. To determine the impact on the total value of construction in all four categories, I calculated the average value of each category of construction as a percentage of the total average value,¹⁸² multiplied these values by the estimated impacts of the tax differential in each data set, and added the four products, which yielded 0.1778, with a 95 percent confidence interval of [0.064 , 0.291]. This means that, on average, a 1 percentage point increase in the tax differential will yield an increase in the total value of construction of 17.8 percent.¹⁸³

The final conclusion of the empirical analysis, given the available data and assuming the validity of the two models that were used, is therefore that the two-rate tax has a significant effect on the number of building permits, although not on the construction value per permit. The estimated overall impact of a 1 percentage point increase of the tax differential on the total value of construction is 17.8 percent and is statistically significant. One might wonder how easily these results can be generalized to other cities. The study has examined only 15 cities in one single state, while it has not been shown that other cities in other states would make similar experiences. This question can be raised about the possibility of generalizing any empirical study. To make a well-founded general claim, it will be necessary to repeat the analysis with additional cities. Unfortunately Pennsylvania is the only state that allows its cities to tax land and structures at different rates, which prevents another analysis with data from the United States. However, neither the data nor economic theory give any indication that the results of this study should hold only in Pennsylvania. An analysis of the two-rate tax system in Australia (Lusht, 1992) yielded comparable results, which gives some indication that conclusions beyond the examined cities are possible.

¹⁸² The average values are as follows: Residential whole units: \$781,276, Residential additions and alterations: \$1,249,369, Nonresidential whole units: \$1,223,079, Nonresidential additions and alterations: \$1,249,369.

¹⁸³ It is interesting to note that Tideman and Johnson (1993) estimated this overall impact to be 18.1 percent, although their standard error of estimate was too large (0.1156) to yield statistical significance.

8.2 Deficiencies of the analysis and suggestions for further research

No empirical analysis is ever ‘complete’ in the sense that it would not be possible to improve upon the work once it has been declared ‘done’. This naturally also applies to this dissertation. To increase the precision of the results, it would be possible, and maybe even necessary, to extend the study in two directions. First, it would be important to refine the available data set, and second, it would be interesting to test the robustness of the results by examining the effects of additional distributional assumptions.

To begin with, the available data is not as informative as it could be. As pointed out earlier, it was not possible to gather enough information about the determinants of construction on the municipality level to avoid the problem of omitted variables; this made it necessary to undertake fixed effects analyses. Yet the dummy variables explain only the average number of permits by each city, and do not explain the year-to-year changes in these numbers. If the tax variable is correlated with another variable that is not included and that has a substantial impact on construction, the analysis will either overstate or understate the effect of the two-rate tax. Alternatively, the unexplained fluctuations around the dummy average might be too large to show a significant tax coefficient for the value of construction, even though additional data might explain some of these fluctuations, and reveal a significant tax impact. Yet the possibility of omitted variables is a general problem of every empirical analysis, and it does not reflect any repairable defect of this study.

A second problem lies in the fact that the data set that was obtained from the Bureau of the Census has several deficiencies. Very often municipalities do not report information about their building permits, and many observations for the two-rate cities for the time before and the time after the introduction of the two-rate tax are missing.¹⁸⁴ This reduces the possibility of finding a significant tax effect. It would be valuable to repeat the study after securing this crucial information. In addition, the data set that is available on disk only extends back to 1980, and for the time before 1980 only information about the number of new residential building permits is available. Yet Pittsburgh experienced a construction boom in the early 1980s, shortly after the ratio of city land tax to city structure tax was increased from 2:1 to more than 5:1. The available data do not permit conclusions to be drawn about the role that the increase in the tax differential might have played in triggering this construction boom,

¹⁸⁴ For example, a complete data set of nonresidential whole units should consist of 225 entries for the 15 two-rate cities between 1980 and 1994. Yet it has only 171 entries; 54 observations are missing, of which 29 fall into the important time after the cities had implemented the two-rate tax. No information after the introduction of the two-rate tax is available for Coatesville and Connelsville (7 missing observations), so that the group of interest that can be examined with the available data actually does not consist of 15 but only of 13 cities. Appendices A and B show the available data for all four data sets for the number of building permits and for the value per permit, respectively.

and an analysis that used information about the value of construction for the time before 1980 can be expected to yield more precise results. Finally, half of the cities that implemented the two-rate tax did so only in the second half of the 1980s, and any additional year of data will help to increase the accuracy of the study.¹⁸⁵

A third kind of limitation of the data set is directly related to the information about the tax differential. As pointed out in Sections 2.2.2.1 and 4.6, this study uses only the city property tax, while a more complete analysis would also take the school district tax and the county tax into account and examine the separate impacts of taxes on land and on improvements. However, because so far no county and no school district with the exception of the school district of Aliquippa has adopted a two-rate tax, this would not change the tax differential, but yield only a better measurement of the whole tax burden that is put on construction in Pennsylvania.¹⁸⁶

A further limitation is related to the fact that cities frequently offer some form of tax abatement for new construction. For example, in the early 1980s Pittsburgh decided not to tax the additional value of a building due to construction for the first three years.¹⁸⁷ This means that the true tax differential for new construction is higher than the differential that is related to existing structures; Weir and Peters (1986) conclude that the tax abatement policy had a substantial impact on Pittsburgh's construction activities in the early 1980s. An analysis with a revised tax differential that takes account of tax abatement policies would probably show an even stronger impact of the two-rate tax than the current analysis. In addition it would be interesting to investigate how many flat-rate municipalities have implicitly introduced a two-rate tax by granting tax abatement to new construction.¹⁸⁸

While the precision of the analysis could certainly be improved with additional data, it might also be possible to refine the model in Chapter 6 even further. The Gibbs Sampler analysis assumes a mixture of Poisson and lognormal distributions; although nothing indicates that this assumption is unjustified, it would be informative to examine further mixtures. For

¹⁸⁵ Unfortunately the Bureau of the Census is likely to discontinue the publication 'Housing Units Authorized by Building Permits'.

¹⁸⁶ The two-rate tax of the school district of Aliquippa has already been incorporated into the current analysis.

¹⁸⁷ This has reduced Pittsburgh's tax collections from real estate by \$2.7 million in 1984 (Weir and Peters, 1986).

¹⁸⁸ They would still not be true two-rate municipalities, because the tax abatement period is limited to a few years. While this will give some incentive to construct, the incentive for construction will be higher if improvements will permanently face a lower tax rate.

example, a useful test of the model would be the use of a mixture of Poisson and Student-*t* distributions, which would give additional information about the robustness of the results.

8.3 Conclusion

What has been achieved by this study? On the one hand, the dissertation has developed several new insights into the analysis of count data. While conventional maximum likelihood analyses with the negative binomial distribution have used a restricted functional form to describe heteroskedasticity, the analysis in Chapter 5 has shown that it is possible to improve the estimates by modeling the heteroskedasticity with a more general function that is determined by the available data. In addition, previous studies have used the negative binomial distribution for every count data set with overdispersion, regardless of the possibility that the data were generated by a different distribution. Chapter 6 describes a possibility of using an alternative to the negative binomial distribution that has not been used previously for the analysis of economic count data. This distribution was implemented through the Gibbs Sampler, which few econometricians have applied until now. Because of its generality and because it is relatively straightforward to implement, the Gibbs Sampler can be expected to have a noticeable impact on future econometric work.

Besides the technical developments, this study also provides an insight into some of the economic consequences of adopting a liberal ethical theory as motivation of economic policy. Classical liberalism asserts that all people have a right to themselves and to the proceeds of their labor, and that they have equal claims to the value of natural opportunities. In a world where the supply of natural opportunities is limited, this assertion requires the public collection of the total rent that natural opportunities provide. To avoid this liberal conclusion, one must propose an alternative theory of property rights that denies the equal claim to natural opportunities, for example that natural opportunities belong to whoever appropriated them first, or to whoever has last seized them. Some implications of these theories, however, contradict the liberal claim that people are born with equal rights,¹⁸⁹ which makes the theories rather unattractive for someone who supports liberal ideas. In view of the criticism that is frequently raised against neoclassical economic theory, further research about the relationship between economic and moral theories would be of great importance.

Liberal ethical theories are non-consequentialist philosophical theories, because they prescribe actions irrespective of the economic consequences. Yet some economic consequences might be considered to be so undesirable that, even though the action that leads to

¹⁸⁹ Although it may be possible to define 'equal rights' in a different way, none of the claims to natural opportunities that one can make according to these theories is justified if one accepts Bruce Ackerman's definition of 'neutrality' (see Section 1.3) and his requirement that all claims have to be 'neutral claims'.

these consequences is just, a society might still decide that its ethical and (potentially) economic benefits do not outweigh the economic cost. This dissertation has examined the economic consequences of shifting some of the property tax from buildings to land; until now there was no empirical evidence that such a tax shift has any economic consequences at all. The analysis in the previous chapters provides strong empirical evidence that shifting the property tax from buildings to land leads to increased construction activity.

An increase in construction activity does not automatically indicate that the two-rate tax is advantageous. To reach this normative conclusion, we must add the normative premise that the additional construction that people undertake when taxes are removed is good. There is evidence that the cities in Pennsylvania that adopted a two-rate tax did so exactly because of its stimulating effect on construction, which they considered desirable because it would help them to overcome their economic distress. One can conclude therefore that, although increased construction activity may not always be a good thing, it was considered a good thing in the 15 cities, and that the shift to the two-rate tax regime had desirable economic consequences for these cities. The result of this study might therefore persuade more communities, at least distressed ones, to consider implementing the two-rate tax.

If one wants to proceed further with the implementation of the ethical framework, one needs to consider the justification of taxes other than a tax on natural opportunities. One consequence of the proposition that people own themselves is that it becomes objectionable to coerce people to pay taxes on the return to their labor and on the capital that they accumulate. Unless people are prepared to voluntarily contribute a part of their return on labor and capital, a tax on the rent that is gained from natural opportunities therefore remains the only possibility for financing government expenditures.¹⁹⁰ Yet it is often claimed that even if the full rent of natural opportunities is taxed, the proceeds are by far not high enough to finance today's budget of the United States. Very little empirical work has been done yet to estimate the whole rent that is gained from the use of natural opportunities like sites, water, minerals, or the radio spectrum.¹⁹¹ It is conceivable that a tax on rent would be enough to finance a budget of \$1.5 trillion, and the answer to this question will be of great importance for the discussion of the future of the tax on rent.

¹⁹⁰ Taxes on labor and capital are acceptable in the context of the ethical framework if they can be considered voluntary payments for public goods. In a Tiebout world without moving cost and equal access to natural opportunities, especially space, people who regard the marginal benefit of the public good as lower than their own contribution have the opportunity to relocate and to establish their own community with their preferred contribution scheme.

¹⁹¹ See for example Cord (1985).