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Working Paper 7603
http://www.nber.org/papers/w7603

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2000

The authors would like to thank the Zell Center for Real Estate Research, Wharton School, University of Pennsylvania for financial support. Haughwout and Inman also received support from the National Science Foundation. The comments of Howard Chernick, Joe Gyourko, Todd Sinai, Anita Summers, and John Quigley are appreciated as are those of seminar participants at Princeton University, the Wharton School, the ZEW Federalism Conference, the Norwegian Tax Forum 1999, the NBER Summer Institute Public Finance Workshop, and the 1999 Meetings of the American Public Policy and Management Association. The views expressed herein are those of the authors and not necessarily those of the National Bureau of Economic Research or the Federal Reserve Bank of New York.

Local Revenue Hills:

A General Equilibrium Specification with Evidence from Four U.S. Cities

by

Andrew Haughwout, Robert Inman, Steven Craig, Thomas Luce[1]

Adam Smith: High taxes, sometimes by diminishing consumption of the taxed commodities, and sometimes by encouraging smuggling, frequently afford a smaller revenue to government than what might be drawn from more moderate taxes. (From Adam Smith, *The Wealth of Nations*, book V, Chapter II.)

Alexander Hamilton: It is a signal advantage of taxes on articles of consumption that they contain in their own nature a security against excess. . . . If duties are too high, they lessen the consumption; the collection is eluded; and the product to the treasury is not so great as when they are confined within proper and moderate bounds. (From "Further Defects of the Present Constitution," *Federalist Papers*, No. 21.)

Jules Dupuit: If a tax is gradually increased from zero up to the point where it become prohibitive, its yield is at first nil, then increase by small stages until it reaches a maximum, after which it gradually declines until it becomes zero again. (From Jules Dupuit, "On the Measurement of Utility from Public Works," reprinted, in K. Arrow and Tibor Scitovsky (1969), *Readings in Welfare Economics*, Homewood, Il: Richard D. Irwin.)

John Maynard Keynes: Nor should the argument seem strange that taxation may be so high as to defeat its object, and that, given sufficient time to gather the fruits, a reduction of taxation will run a better chance than increase of balancing the budget. (From John Maynard Keynes, *Collected Works of John Maynard Keynes*, St. Martin's Press, p. 338.)

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JEL No. H2, H71, R51

ABSTRACT

We provide estimates of the impact and long-run elasticities of tax base with respect to tax rates for four large U.S. cities: Houston (property taxation), Minneapolis (property taxation), New York City (property, general sales, and income taxation), and Philadelphia (property, gross receipts, and wage taxation). Results suggest that all four of our cities are near the peaks of their longer-run revenue hills. Equilibrium effects are observed within three to four fiscal years after the initial increase in local tax rates. A significant negative impact (current period) effect of a balanced budget increase in city property tax rates on city property base is interpreted as a capitalization effect and suggests that marginal increases in city spending do not provide positive net benefits to property owners. Estimates of the effects of taxes on city employment levels for New York City and Philadelphia – the two cities for which employment series are available – show the local income and wage tax rates have significant negative effects on city employment levels.

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Understanding the equilibrium effects of taxation on the level and location of economic activities, long a concern of public finance economists, is now a priority for policy advisors and elected officials as well. Today, almost no city, state, or national budget fails to mention the wisdom of controlling taxes to enhance economic development and job growth. Further, understanding how tax rate changes affect the equilibrium level of tax revenues – called "dynamic revenue scoring" – defines the government's equilibrium budget constraint and is now viewed as essential for sound fiscal planning (Auerbach, 1995). While there is general agreement that taxes matter, we are still far from a consensus on how much. This paper provides estimates of the effects of local taxation on the taxed activities in four large U.S. cities: Houston, Minneapolis, New York City, and Philadelphia.

The analysis is useful for at least four reasons. First, large cities are important economic centers. Poorly designed tax policies may have adverse effects on the levels and locations of economic activities within large cities, with potentially significant costs in lost agglomeration economies in both the production of goods and services and in the generation of new ideas (Glaeser, Kallal, Scheinkman, Shleifer, 1992). We provide estimates of the effects of tax changes on changes in the level of taxed activities within our sample cities.[2] Second, in contrast to much of the previous empirical analysis in local public finance, the cities we examine

[2] We know of only five previous studies which look specifically at the effects of taxation on economic activity for large cities: Grieson (1980), Gruenstein (1980) and Inman (1995) examine the effects of the Philadelphia wage tax on city jobs; Grieson, et al. (1977) looks at the effects of the New York City business taxes on aggregate city business activity; Inman (1995) studies the effects of property taxes on property values and business taxes on business activity in Philadelphia; and Mark, McGuire, and Papke (1998) study the effects of property and sales taxation on jobs and employment for Washington, D.C.. Bartik (1991) provides the best overall summary of what we know about the effects of local taxation on economic activity generally.

here are large open city economies containing both firms and households. They are not Tiebout-Oates bedroom suburbs. The appropriate analytic framework is the Rosen-Roback model with endogenous land values and wages (Roback, 1982) extended, however, to allow for household consumption and for household and firm investment in housing and business capital. We provide this extension. Third, in today's increasingly decentralized public economy, cities will be asked to assume expanded responsibilities for the provision of public services, including services and transfers to low income households. Under the terms of the Welfare Reform Act of 1996, additional federal or state aid is unlikely to be forthcoming to meet the full costs of these added welfare responsibilities (Inman and Rubinfeld, 1997). In a mobile urban economy with attractive suburban alternatives, there may be insufficient long-run city taxing capacity to fill the gap. Our empirical results provide the first econometric estimates of a large city's "revenue hills" (*aka* "Laffer Curves") as a basis for measuring the city's equilibrium budget constraint and its ability to meet any new fiscal demands in a post-welfare-reform economy. Fourth, the paper offers additional evidence as to the general sensitivity of tax base to tax rates; see Gruber and Saez (1999; federal personal taxation) and Hines (1999; corporate taxation) for reviews.

Section II presents a general equilibrium model of the effects of city tax rates on city tax bases and revenues. The analysis here provides us with the appropriate specification for our empirical analysis of how changes in rates affect bases and revenues as well as a structural framework within which to interpret estimated effects. Each of the important taxes used by large cities are included in the analysis: property taxation on households and firms, sales and gross receipts taxation, and resident and non-resident wage and income taxation. All four of our sample cities use the property tax. In addition, New York City earns significant revenues from a general sales tax and from a tax on residents' income. Philadelphia uses a gross receipts tax and a tax on residents' and non-residents' wages. Section III describes our data and provides estimates of the effects of changes in tax rates on tax base. Sensitivity analyses of our core results, including instrumental variables estimation to allow for endogenous tax rates, test the robustness of our basic conclusions. Section III also provides estimates of the effects of city taxes on city employment for the two cities (New York City and Philadelphia) for which accurate employment series are available. Section IV presents estimates our cities' current revenue hills. Each of our cities is very near or at the top of its revenue hill(s). Section V provides a few concluding comments.

II. The Effects of Taxation in a Large Open City Economy

Individual large cities offers only one of many competitive locations for residents and firms. Capital, labor, and households are mobile, both across locations in a given economic region and between regions. Capital located in a city must earn the competitive rate of return, goods produced within the city must sell at competitive world prices, labor working in the city but living the suburbs must earn the competitive wage, and residents living and working within the city must receive an overall level of utility comparable to that available outside the city. This section outlines a general equilibrium model of the effects of city taxation and public goods on the levels and location of economic activity to a large, open city. The analysis extends the model of Rosen (1979) and Roback (1982). The model differs in two important respects from previous general equilibrium models of fiscal policy in open economies; for example, Polinsky and Rubinfeld (1978), Brueckner (1981), and Sullivan (1985). First, like Rosen-Roback we close our model by assuming an exogenous supply of city land; thus, land prices are endogenous. Second, in additional to residential property taxation (the focus of previous work), our model also studies the effects of business property taxation, the taxation of labor incomes of residents and non-residents, and sales taxation on domestic consumption and export goods. Like previous fiscal models, however, we assume local tax rates and public services are set exogenously.

Households living in the city consume three private goods -- an all-purpose consumption good (x), housing structures (h), and residential land (ℓ_r) -- and an all-purpose pure public good (G). All endogenous variables of the model are denoted in *italics*. The residents are assumed to purchase the three private goods (x, h, ℓ_r). Consumption goods (x) are purchased at an exogenous world price ($\equiv 1$) plus any local sales tax levied on consumption (τ_s); see Poterba (1996).[3] Housing structures are constructed at the competitive price ($\equiv 1$) and paid for through an annual rental cost sufficient to return a competitive rate of return (r). In addition, residents pay a local property tax (τ_p) levied on the value of housing structures ($= 1 \cdot h$). Households purchase land within the city at an endogenously determined annual rental price (R) and pay the local property tax (τ_p) levied on land values ($= (R/\mathrm{r}) \cdot \ell_r$). The specification here is general with respect to the contribution of land and structures to household welfare as residents get direct utility from both land and structures; see Arnott and MacKinnon (1977). The number of

[3] Requiring residents to consume x within the city removes the effect of local sales taxes on cross-border shopping; see, for example, Walsh and Jones (1988) and most recently Goolsbee (1999) for evidence. In our model residents are free to leave the city when the sales tax is increased.

households living within the city (N) is endogenous. City residents are assumed to work only within the city and to receive an endogenously determined wage (W) less any locally levied resident wage tax (τ_w). Residents maximize a common, well-behaved utility function U(x, h, ℓ_r; G) subject to the budget constraint inclusive of local tax payments:

$$[1+\tau_s]\cdot x + [\mathrm{r}+\tau_p]\cdot h + [\mathrm{r}+\tau_p]\cdot(R/\mathrm{r})\cdot \ell_r = [1-\tau_w]\cdot W,$$

which in turn defines resident demand curves for x, h, and ℓ_r:

(1) $$x = \mathrm{x}(R,\ W;\ \tau_r,\ \mathrm{G};\ \mathrm{r},\ 1);$$

(2) $$h = \mathrm{h}(R,\ W;\ \tau_r,\ \mathrm{G};\ \mathrm{r},\ 1);$$

(3) $$\ell_r = \ell_r(R,\ W;\ \tau_r,\ \mathrm{G};\ \mathrm{r},\ 1);$$

where τ_r represents the vector of exogenous residential tax rates $\{\tau_s,\ \tau_p,\ \tau_w\}$.[4]

Long-run spatial equilibrium requires that residents or households planning to live within the city achieve the same level of utility as available to them outside the city. Given a household's demands for x, h, and ℓ_r, the indirect utility function for a typical resident can be specified and set equal to an exogenous utility (V_0) available outside the city:

(4) $$\mathrm{V}(R,\ W;\ \tau_r,\ \mathrm{G};\ \mathrm{r},\ 1) = \mathrm{V}_0.$$

Firms within the city buy capital (K), resident labor (N), non-resident or imported labor

[4] Implicit in this specification of the household budget constraint are four assumptions which define the initial incidence of local taxation. First, the supply of consumption goods (x) is perfectly elastic to city residents; residents therefore bear the initial burden of the local sales tax. Second, there is a perfectly elastic supply of housing structures to city residents; residents therefore bear the initial burden of the portion of the property tax which falls on structures. Third, all residents own land in the city; residents therefore bear the burden of the portion of the local property tax which falls on resident owned land. Fourth, given the full mobility of firms, there is a perfectly elastic demand for resident workers; residents therefore bear the initial burden of the resident wage tax. Under the assumptions of our model, the equilibrium incidence of local taxation will be borne by landowners.

(M), and land (L_f) to produce the common consumption good (X); the aggregate production technology for city firms is assumed to be constant returns to scale (linear homogeneous) over these four private market inputs. Firms also use the exogenously provided all-purpose public good (G) as a production input; G is assumed to influence firm production as a beneficial Hicks-neutral shift in the marginal productivities of the private inputs. Firms buy capital at its exogenous market price ($\equiv 1$) and pay an annual cost of capital equal to the competitive rate of return (r) plus any local property tax (τ_p) levied on the value of that capital ($= 1 \cdot K$). Firms hire resident labor N at the endogenously determined resident wage (W). Non-resident labor (M) is paid an exogenous non-resident wage (s) needed to attract non-resident workers to city jobs plus a compensating differential for non-resident labor taxes imposed by the city at the rate τ_m.[5] The gross-of-tax wage paid by city firms to non-resident workers equals $(1+\tau_m)\cdot s$. Finally, firms use land within the city paying the annual rental rate (R) plus the property tax (τ_p) on the value of that land ($= (R/r)\cdot L_f$). For production efficiency, firms within the city maximize output defined by their common constant returns production technology needed to produce one unit of X, given G -- $1 = X(k, n, m, \ell_f; G)$, where $k = K/X$, $n = N/X$, $m = M/X$, $\ell_f = L_f/X$ -- subject to a constant average cost constraint inclusive of local tax payments:

$$c = [r + \tau_p]\cdot k + W\cdot n + [1+\tau_m]\cdot s\cdot m + [r+\tau_p]\cdot(R/r)\cdot \ell_f,$$

where k, n, m, and ℓ_f measure inputs per unit output. The resulting firm demands for factor inputs, specified here as demand per unit output, are:

[5] When specifying the effect of non-resident wage tax rates on tax base we recognize that cities will actually tax the gross-of-tax wage. If ϕ_m is the actual rate imposed on the gross-of-tax wage and τ_m is an implied rate on net-of-tax wages, then identical revenues will be raised and economic behaviors will be identical when $\phi_m\cdot[(1+\tau_m)\cdot s] = \tau_m\cdot s$ or when we define $\tau_m = (\phi_m/1 - \phi_m)$. Our empirical results are unaffected by this re-specification.

(5) $$k = \mathrm{k}(R,\ W;\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s});$$

(6) $$n = \mathrm{n}(R,\ W;\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s});$$

(7) $$m = \mathrm{m}(R,\ W;\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s});$$

(8) $$\ell_f = \ell_f(R,\ W;\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s});$$

where τ_f represents the vector of exogenous factor tax rates $\{\tau_p, \tau_m\}$.

Long-run spatial equilibrium does not allow city firms to make excess profits or losses solely because of city location. City firms' long-run average costs must therefore equal the competitive price of the produced good ($\equiv 1$) less any city taxes imposed on the value of the firms' gross output (τ_X). Based upon the factor demand curves above, the firms' zero excess profit constraint will be defined as average revenue ($1) minus per unit taxes (τ_X) minus average cost:[6]

(9) $$1 - \tau_X - \mathrm{c}(R,\ W;\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s}) = \Pi_0(R,\ W;\ \tau_X,\ \tau_f,\ \mathrm{G};\ \mathrm{r},\ \mathrm{s},\ 1) = 0.$$

The spatial equilibrium conditions specified by eqs. (4) and (9) define the equilibrium values (denoted by *) of R and W; see Figure 1. The household utility constraint (eq. (4)) is represented by one of a family of rising indifference curves, $\mathrm{V}(\cdot) = \mathrm{V}_0$, in the {R, W} space. The firm profit constraint (eq. (9)) is shown as one of a family of the declining profit curves,

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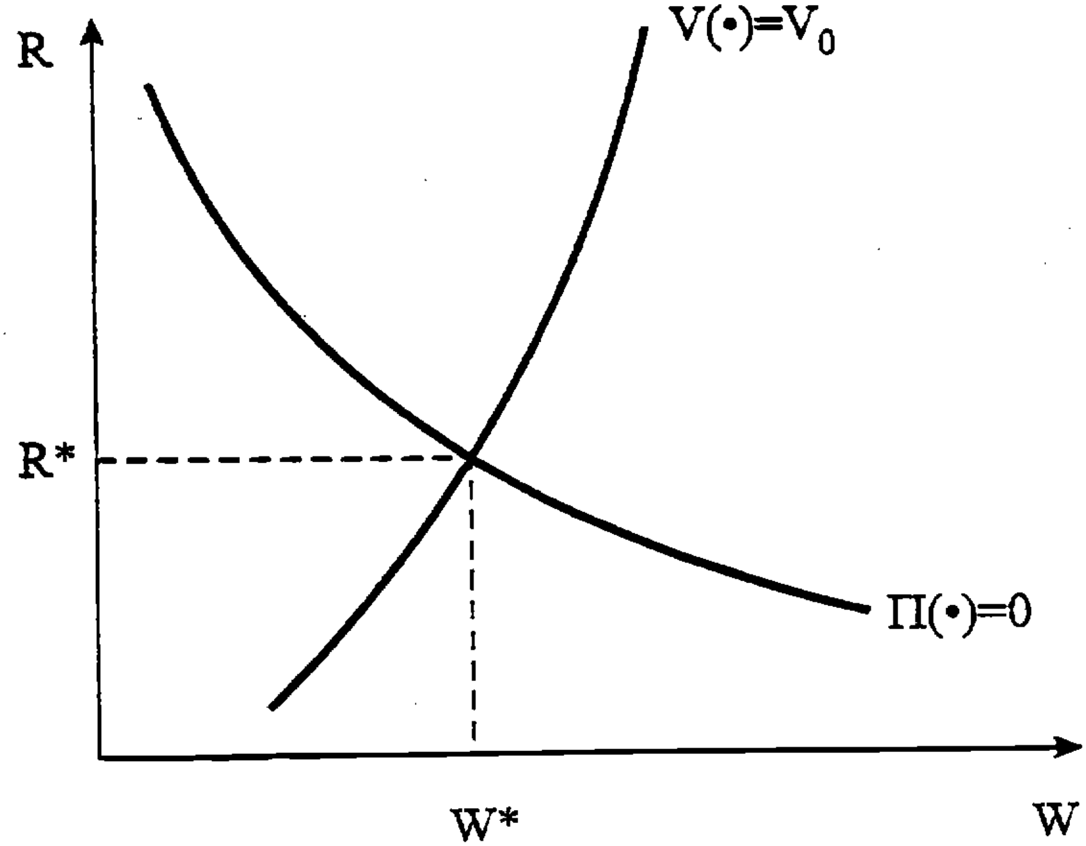
[6] Implicit in this specification of the firm's after-tax profits are four assumptions which define the initial incidence of local taxation on firms. First, the supply of capital equipment is perfectly elastic; firms therefore bear the initial burden of the portion of the local property tax which falls on firm capital. Second, there is a perfectly elastic supply of suburban workers to city firms; firms therefore bear the initial burden of a non-resident wage tax. Third, all firms own land in the city; firms therefore bear the burden of the portion of the local property tax which falls on firm owned land. Fourth, there is an elastic demand for city firm output in the world market; city firms therefore bear the initial burden of any tax imposed by the city on firm output. Again, given the assumptions of our model, the final burden of these local taxes is shifted back onto land values.

Figure 1

Rent-Wage Equilibrium in an Open City



$\Pi_0(\cdot) = 0$. Citizens will be better off if they can move to an indifference curve below V_0 (earning higher wages and/or paying lower rents) and firms will be more profitable by moving to a profit curve below $\Pi(\cdot) = 0$ (paying lower wages and rents). The equilibrium wage (W^*) and rent (R^*) defined by the intersection of $V_0(\cdot)$ and $\Pi_0(\cdot)$ in Figure 1 are consistent with each resident receiving V_0 and each city firm receiving no excess profits or losses.

$$R^* = R(\tau_r, \tau_f, \tau_X, G; r, s, 1; V_0), \tag{10}$$

$$W^* = W(\tau_r, \tau_f, \tau_X, G; r, s, 1; V_0). \tag{11}$$

Eq. (10) specifying R^* as a function of exogenous tax rates, public services, and market prices is a typical land value ($= R^*/r$) capitalization equation.[7] Equation (11) is the counterpart wage capitalization equation as specified in Rosen (1979) and Roback (1982). Substituting these specifications for R^* and W^* into eqs. (1)-(3) and (5)-(8) defines the equilibrium values of household goods demands per resident (x^*, h^*, ℓ_r^*) and firm factor input demands per unit of local output (k^*, n^*, m^*, ℓ_f^*), respectively.[8]

Aggregating household and factor demands now allows us to specify equilibrium tax bases for each city tax. The tax base per resident for city property taxation equals:

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[7] The familiar Tiebout-Oates capitalization equation is a special case of eq. (10). With no firms competing for city land, resident demands fully determines land rents. Thus, $V(R; \tau_r, G; W, r, 1) = V_0$, and therefore $R = R(\tau_r, G; W, r, 1; V_0)$.

[8] The model is closed by fixing the aggregate supply of land in the city. Aggregate production by firms within the city, X^*, is determined by the equilibrium in the land market. We assume each city has a fixed aggregate supply of land, L_s, which must equal the equilibrium aggregate demand for land by firms and households. Firms demand ℓ_f^* units of land for each unit of X^* produced, while the n^* households employed by firms per unit of X^* produced each demand ℓ_r^* units of land. The amount of land demanded in equilibrium is $[\ell_f^* + n^*\ell_r^*]$ per unit of X^* produced. The aggregate demand for land is therefore $L_d^* = [\ell_f^* + n^*\ell_r^*]\cdot X^*$. Setting $L_s = L_d^*$ to clear the city land market implies: $X^* = L_s/[\ell_f^* + n^*\ell_r^*]$; see Haughwout (1998). Aggregate city resident employment is specified as: $N^* = n^*X^*$.

$$B_p{}^* = k^*/n^* + (R^*/\mathrm{r})\{\ell_r{}^* + (\ell_f{}^*/n^*)\} + h^*,$$

$$B_p{}^* = \mathrm{B_p}(\tau_\mathrm{r}, \tau_\mathrm{f}, \tau_\mathrm{X}, \mathrm{G}; \mathrm{r}, \mathrm{s}, 1, \mathrm{V_0}); \tag{12}$$

for city sales taxation:

$$B_s{}^* = x^*,$$

$$B_s{}^* = \mathrm{B_s}(\tau_\mathrm{r}, \tau_\mathrm{f}, \tau_\mathrm{X}, \mathrm{G}; \mathrm{r}, \mathrm{s}, 1, \mathrm{V_0}); \tag{13}$$

for resident wage taxation:

$$B_w{}^* = W^*,$$

$$B_w{}^* = \mathrm{B_w}(\tau_\mathrm{r}, \tau_\mathrm{f}, \tau_\mathrm{X}, \mathrm{G}; \mathrm{r}, \mathrm{s}, 1, \mathrm{V_0}); \tag{14}$$

for non-resident wage taxation:

$$B_m{}^* = \mathrm{s}\cdot m^*/n^*,$$

$$B_m{}^* = \mathrm{B_m}(\tau_\mathrm{r}, \tau_\mathrm{f}, \tau_\mathrm{X}, \mathrm{G}; \mathrm{r}, \mathrm{s}, 1, \mathrm{V_0}); \tag{15}$$

and for local gross receipts taxation (remembering n^* is resident-worker per unit of local output):

$$B_X{}^* = 1/n^*,$$

$$B_X{}^* = \mathrm{B_X}(\tau_\mathrm{r}, \tau_\mathrm{f}, \tau_\mathrm{X}, \mathrm{G}; \mathrm{r}, \mathrm{m}, 1, \mathrm{V_0}). \tag{16}$$

Though the model presented here is relatively simple, a priori predictions for the effects on tax base of changes in tax rates and public good provision are generally not possible without a parameterization of preferences and technologies. Fiscal policies which affect the attractiveness of the city to both households and firms shift both the households' break-even indifference curve and firms' zero profit curve in Figure 1, preventing a priori predictions for R^* and W^*. Without knowing the changes in R^* and W^*, no a priori predictions are possible for household consumption, factor utilization, and finally tax bases.[9] Matters must ultimately be resolved empirically.

The theoretical analysis has made clear that a correctly specified model of the economic consequences of local taxes in an open city economy must include all local tax rates and local public services in each tax base equation and that the full effects of rates and services on base are observed only after equilibrium adjustments in local land and labor markets. Further, both local tax rates and local public goods are seen to impact on tax base. Thus specifying an equilibrium relationship between tax base and tax rates alone -- and ultimately a city's revenue hill -- requires a specification for how changes in tax rates change public goods. This is provided by the government's budget identity:

$$G \equiv [\Sigma_i \tau_i \cdot B_i + Z]/c,$$

where Z are non-tax revenues and c is an index of local public service costs; see Inman (1979). Substituting the budget identity for G into eqs. (12)-(16) provides the final general equilibrium, balanced budget relationship between tax rates, tax base, and tax revenues:

$$(17) \qquad B_i = B_i(\tau_r, \tau_f, \tau_X, Z, c; r, s, 1, V_0),$$

and between tax rates and tax revenues:

$$(18) \qquad T_i = \tau_i \cdot B_i(\tau_r, \tau_f, \tau_X, Z, c; r, s, 1, V_0),$$

[9] See Haughwout and Inman (2000). One prediction is possible: $dB_w^*/d\tau_w > 0$. A *ceteris paribus* increase in the city resident wage tax rate makes city residency less attractive. Thus V_0 moves to a lower indifference curve in Figure 1, sliding down the fixed Π_0 schedule, thereby reducing the equilibrium value of R^* while raising W^*. As $W^* = B_w^*$, $dB_w^*/d\tau_w > 0$. Mayors should be careful with this result, however. Since resident wages have risen, firms will hire fewer resident workers for each unit of output. This result is also found in the models of Polinsky and Rubinfeld (1978) and Brueckner (1981).

for each local tax base [i = p, s, w, m, X].[10]

The city's equilibrium revenue frontier is now defined as the aggregate of all city revenues for each combination of city tax rates, specified as:

$$\Re = \Sigma_i \tau_i \cdot B_i(\tau_r, \tau_f, \tau_X, Z, c; \cdot) + Z. \tag{19}$$

A small increase in any individual tax rate ($= \Delta\tau_j$), when coupled with adjustments in local public goods as required by the city's budget identity, results in an equilibrium balanced budget change in city revenues of:

$$\Delta\Re = \Delta\tau_j \cdot B_j + \Sigma_i \tau_i \cdot \{B_i \cdot \varepsilon_{ij} \cdot \Delta\tau_j/\tau_j\}. \tag{20}$$

The first term measures the direct revenue effect of a small increase in the tax rate τ_j (j = p, s, w, m, X). The second term measures the indirect effect of the rate increase as local tax bases respond to changes in local tax rates and to balanced budget adjustments in G. The expression within {} measures the change in each B_i because of the small change in τ_j; ε_{ij} is the elasticity of B_i with respect to changes in τ_j. Since tax revenues are allocated to the purchase of public goods, it is possible that the ε_{ij}'s are positive -- for example, land taxes used to finance valued public goods as in Brueckner (1982). For the general tax structures modeled here, however, negative ε_{ij}'s are also possible; see Haughwout and Inman (2000). Values of ε_{ij}'s are therefore an empirical issue. We will estimate ε_{ij}'s for Houston, Minneapolis, New York, and Philadelphia and use those estimates to place each city on its current revenue hill.

[10] Assuming, as we do, that the conditions for the Implicit Function Theorem hold for the system of tax base equations plus the budget identity. Sufficient for a stable equilibrium specification is that $c > \Sigma\tau_i \cdot \partial B_i/\partial G$, or in words, increasing G cannot bring in more in tax revenues ($\Sigma\tau_i \cdot \partial B_i/\partial G$) than it costs to produce the good (c). This "reduced-form" approach to specifying the equilibrium tax base equations is similar to that used by Vigdor (1998) in his study of the property tax base for resident-only communities.

III. Data and Estimation

A. Data

The Data Appendix provides a summary of the data used in our analysis. All four cities use a property tax (B_p, τ_p); New York uses a general sales tax (B_s, τ_s);[11] New York uses an income tax based upon the federal income tax definition of taxable income (B_w, τ_w);[12] and Philadelphia imposes a resident (B_w, τ_w) and non-resident wage tax (B_m, τ_m) and a gross receipts tax (B_X, τ_X). Unfortunately, Philadelphia data are not available to separate wage taxes collected between residents and non-residents; we therefore estimate an average Philadelphia wage tax base equation (B_{w+m}). For New York City and Philadelphia we also estimate a city employment equation relating aggregate employment ($N + M$) to local tax rates.

The property tax base per resident (B_p) in each city is the aggregate market value per resident of all taxable property as estimated by each city from its tax roles using samples of "arm's length" sales of properties within the city.[13] The sales tax base (B_s) and the income tax base (B_w) per resident for New York City are the City's estimates from tax returns of aggregate retail sales and aggregate taxable wage and unearned (investment) income, respectively.

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[11] Houston and Philadelphia also use a general sales tax, but there is insufficient variation in the sales tax rate over time to allow estimation of a revenue hill.

[12] The wage tax base is approximately 75 percent of taxable income in New York City; see *Tax Revenue Forecasting Documentation: Financial Plan, FY 1994-98*, City of New York, Office of Management and Budget, 1994. New York City also imposes a non-resident income tax, but rates and revenues are low and rate variation is insufficient for empirical analysis.

[13] The estimates are not from (possibly biased) assessor's estimates, but from actual sales. Similarly, when specifying the effective tax rate on property in each city we use the estimated ratio of assessed value to market value (assessment rate) based upon market value as specified by market sales.

Philadelphia's gross receipts tax base (B_X) and wage tax base per resident ($B_w + B_m = B_{w+m}$) are estimates from tax returns of aggregate business sales and of aggregate resident plus non-resident wage income originating in Philadelphia. For New York City and Philadelphia, annual aggregate employment ($N + M$) is also available as each city is also a county (ies for New York); comparable data were not available for Houston and Minneapolis.

Each local tax rate, except for New York City's income tax, is a proportional tax rate. For New York City's progressive income tax we define τ_w as the top marginal rate; estimated elasticities using the median income family's tax rate were similar. In all cities, property tax rates (τ_p) are the effective average tax rate defined as the city's proportional mill rate times the market value weighted average rate of property assessment within the city.[14] New York's sales tax rate (τ_s) and Philadelphia's wage (τ_{w+m})[15] and gross receipts (τ_X) tax rates are the statutory rates. There is significant variation in each city's tax rates, both up and down; see the Data Appendix. All tax rate and tax base data were provided by either the city's Department of Revenue or City Controller.

Other independent variables include: exogenous non-matching federal and state grants-in-

[14] Houston, Minneapolis, and New York City have different classes of property with different effective tax rates for each class. For these cities we create a single tax-based weighted average of the separate property tax rates as our measure of τ_p. The assessment to market value ratios are based upon market value as estimated from an annual sample of arm's length sales of market properties.

[15] The Philadelphia wage tax rate used to explain the aggregate resident plus non-resident wage tax base is a weighted average of the resident (τ_w) and non-resident (τ_m) wage tax rates, specified as $\tau_{w+m} = .7 \cdot \tau_w + .3 \cdot \tau_m$, where the weights were provided by the Philadelphia Department of Revenue, based on periodic Department surveys. We thank Mr. Michael Isard for this data.

aid to the city (including school aid) minus net spending by the city on welfare (Z);[16] exogenous determinants of the cost of local public goods (c) measured by changes in the national industrial producer price index (1994 = $1.00); resident interest rates (r) measured by the AAA corporate borrowing rate; non-resident wages (m) measured by national average hourly earnings in nonagricultural industries; and the national rate of violent crime (CRIME) as a measure of the relative attractiveness to residents of moving from the city to the suburbs (V_0); see the Data Appendix. (Unfortunately, continuous time series of city-specific crime rates were not available for our four cities.) The relatively short sample periods in our study preclude us from including all these exogenous variables in each tax base equation. As an alternative we will therefore use two aggregate proxies for the time series patterns in these variables -- a simple time trend (TIME) and the national rate of unemployment for civilian workers (UE) -- and then include each of the exogenous variables individually for separate analysis.

Also included in each tax base equation are measures of possibly important exogenous economic or policy "shocks" specific to each city's economy. For Houston's property tax base equation we test for the impact of the annual rate of change in crude oil prices (ΔFUEL). For Minneapolis we test for the effects of seven years (1982-1988) of exogenous state funding for downtown city construction, including a convention center and a new sports stadium (STADIUM). For New York City we include the annual change in the inflation-adjusted Dow Jones industrial average (ΔDOW) in each tax base equation. For Philadelphia we test for the effects of changes in the national level of health care expenditures (ΔHEALTH) on tax bases.

[16] Since the mobile middle class and firms determine land values and wages within the city, we use only exogenous aid which can be allocated to middle class and/or business services. Thus city welfare spending is subtracted from total exogenous grants-in-aid.

Both New York City and Philadelphia tax bases also may have been affected by policy "shocks" from neighboring states, in particular, the introduction of the New Jersey state income tax in 1976 and, for New York City, the introduction of the Connecticut state income tax in 1991. We include year indicator variables for the introduction of these taxes in the New York City and Philadelphia base equations. Finally, beyond their decisions to set local tax rates, we test for an independent effect of mayoral reputation on tax base by including indicator variables for the nationally prominent mayors in our sample: Mayors Rizzo and Rendell in Philadelphia, and Mayors Koch, Dinkins, and Giuliani in New York City.

The tax base equations specified as eq. (17) are estimated here in first-differences to allow for possible non-stationarity of the level time series in tax base and tax rates.[17] A test for the possibility of pooling our four sample cities to obtain more precise estimates of the effects of tax rates on the property tax base rejected pooling for these four cities.[18] All base equations are therefore estimated separately for each city. Initial core equation estimates (Tables 1-3) are by OLS. Final equation estimates (Table 4) allow for the possible simultaneity of local

[17] If we hope to recover the underlying structural relationship between tax rates and tax base from time series data, it is essential that all variables in the underlying relationship be generated by stationary stochastic processes. Augmented Dickey-fuller tests (available upon request) reveal each of our national and city time series are first-order integrated processes I(1). Given these results, all equations will be estimated in first differences. ADF test statistics for the residuals from the estimated core equations and the corresponding MacKinnon (1991) critical values are available upon request.

[18] A pooled regression regressing ΔB_p on a constant term, $\Delta\tau_p$, ΔUE, ΔZ, and $\Delta CRIME$ has an unadjusted $R^2 = .28$. The pooled regression of ΔB_p on city-specific constants and each variable interacted with a city-specific indicator has an unadjusted $R^2 = .53$. An F test for the significance of all interaction terms as a test of validity of pooling rejects the null hypothesis of pooling at the .02 level of significance: $F_{15,74} = 2.507$. Significant interactions were observed for all tax rates.

tax rates and tax base. Instruments for tax rates include exogenous regulatory and political events likely to affect local tax rates but not directly influence city tax bases -- e.g., local political election cycles, state tax rates, state spending other than grants to cities, the political composition of the state legislatures, the political party of the governor, and a variety of city specific regulatory events. IV estimates are provided even for local tax rates set by the state (New York City sales and income tax rates) or requiring state approval (Philadelphia wage tax rates) under the assumption that approval by the state may also be sensitive to changes in local tax bases.

B. Estimation: Core Results

Tables 1 and 2 present our core estimates of the effects of changes in city tax rates on changes in city tax base as well as estimates of each city's short-run and longer-run elasticities of base with respect to own tax rate (ε_{ii}). Longer-run elasticities are reported for specifications including three lagged rate changes for property taxation and two lagged rate changes for sales and income taxes; longer lag structures did not contribute significantly to the explanatory power of the estimated equation. The F statistic for the joint contribution of three lagged rate changes ($F(\Delta\tau(-3))$) for property taxation and of two lagged rate changes ($F(\Delta\tau(-2))$) for sales and income taxation are reported in Tables 1 and 2, respectively. Also reported for each equation are the Durbin-Watson test statistic for the null hypothesis of no first-order serial correlation; in no instances do we reject the null hypothesis.

Table 1 presents our core estimates for the property tax base equation for each city, specifying changes in the property tax base per resident (ΔB_p) as a function of a constant term, balanced budget changes in the city's effective property tax rate ($\Delta\tau_p$), the national rate of

Table 1: Property Taxation†

	Houston			Minneapolis			New York			Philadelphia		
	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p	ΔB_p
Constant	721.6	76.26	186.8	373.2	392.4	381.2	110.2	−14.97	59.94	123.3	102.0	89.7
	(705.0)	(781.9)	(1,000.0)	(235.7)	(247.4)	(244.8)	(332.2)	(369.3)	(341.7)	(134.9)	(157.9)	(158.8)
$\Delta\tau_p$	−14,203.1*	−17,444.7*	−17,943.2*	−2,308.3*	−2,524.8*	−1,205.9	−10,715.4*	−10,673.0*	−10,130.8*	−3,078.6*	−3,021.8*	−3,091.7*
	(5,891.7)	(6,491.4)	(8,163.3)	(896.9)	(951.0)	(1,246.8)	(1,517.9)	(1,663.2)	(1,793.7)	(603.9)	(625.9)	(721.9)
$\Delta\tau_p(-1)$	—	—	2,634.7	—	—	−2,115.3	—	—	−1,121.7	—	—	−123.4
			(7,406.3)			(1,279.9)			(2,023.2)			(807.6)
$\Delta\tau_p(-2)$	—	—	9,076.5	—	—	−1,261.2	—	—	926.2	—	—	−1,257.8
			(6,869.9)			(1,091.5)			(2,121.7)			(767.9)
$\Delta\tau_p(-3)$	—	—	302.9	—	—	−1,170.2	—	—	−2,709.7	—	—	−1,288.7
			(6,610.7)			(954.4)			(1,906.6)			(718.2)
ΔUE	—	−2.56	426.3	—	267.2	−122.7	—	303.4	314.8	—	−174.6	−176.5
		(664.3)	(761.8)		(252.4)	(354.5)		(368.5)	(365.5)		(140.6)	(147.3)
ΔZ	—	38.81	39.09	—	3.22	1.19	—	1.09	.35	—	.75	−.08
		(35.89)	(41.92)		(2.21)	(2.28)		(1.57)	(1.68)		(1.88)	(2.32)
ΔCRIME	—	41.48	—	—	−.43	—	—	5.59	—	—	3.44	—
		(27.50)			(7.61)			(12.12)			(4.79)	
D.W.	1.32	1.45	1.52	1.50	1.31	2.15	1.12	1.43	1.24	1.40	1.65	1.72
$\bar{R}^2$	0.17	0.19	0.06	0.20	0.18	0.32	0.62	0.61	0.61	0.48	0.47	0.50
$\varepsilon_{B,\tau}$	−.95*	−1.17*	−.40	−.28*	−.32*	−.72*	−.91*	−.91*	−1.11*	−.41*	−.40*	−.76*
	(.39)	(.43)	(.93)	(.11)	(.12)	(.26)	(.13)	(.14)	(.18)	(.08)	(.08)	(.24)
$F(\Delta\tau(-3))$	—	—	.59	—	—	2.36*	—	—	.84	—	—	1.58

†Standard errors for each estimated coefficient are reported in parentheses. D.W. is the Durbin-Watson test statistic for serial correlation. $\bar{R}^2$ is the coefficient of determination corrected for degrees of freedom. The elasticity of tax base with respect to tax rates ($\varepsilon_{B,\tau}$) is based on the marginal effects of rates on tax base, calculated for the most recent fiscal year's tax base and tax rate for each city. $F(\Delta\tau(-3))$ is the F statistic testing the null hypothesis that three lagged changes in rates jointly have no influence on change in tax base.

*Coefficient's t statistic ≥ 2.00. Minneapolis' three lagged changes in rates are jointly significant at the .10 level.

unemployment (ΔUE), federal and state aid (including school aid) to the city net of welfare spending (ΔZ), and the national rate of violent crime (ΔCRIME). The constant term provides estimates of the average annual real growth in tax base. We test for the effects of changes in public goods costs (Δc), interest rates (Δr), non-resident wages (Δm), mayoral regimes, and various economic shocks on these core estimates in Section III.C, Table 4 below.

For all four cities, $\Delta\tau_p$ has a statistically significant negative effect on the rate of change of the city's property tax base. In contrast, ΔUE, ΔZ, and ΔCRIME are not statistically significant; a result confirmed in a pooled regression allowing for a common effect across all four cities of ΔUE, ΔZ, and ΔCRIME on ΔB_p (available upon request). The insignificance of ΔZ on city property values is consistent with the estimated negative impact of balanced budget increases in property tax rates on property base. Both results imply additional public monies are being allocated to uses *not* valued by property owners, for example, services for lower income households or for public employee wage increases. City intergovernmental aid does increase city revenues, but there are no important multiplier effects through an enhanced city tax base. The insignificance of ΔCRIME on city property values may be due to the fact that we are forced to use a national crime rate to proxy for local crime, though Cullen and Levitt (1996) in their larger panel study of crime and cities found a similar insignificant effects of crime on home values using city-wide crime rates. Other studies have found higher crime does reduce home values, but only if it occurs in the home's immediate neighborhood; see Thaler (1978), Hellman and Naroff (1979).

What matters most for changes in our sample cities' property tax bases are changes in their tax rates. Table 1 reports the elasticities of each city's property tax base with respect to changes in the city's property tax rate ($\varepsilon_{B,\tau}$), evaluated at the city's most recent year's tax base and rate. The first two columns for each city in Table 1 provide estimates of the one-year, impact elasticity of tax base with respect to changes in tax rates, measured as changes in the market value of the city's tax base over the course of the fiscal year from a change in the city's property tax rate announced before the beginning of the fiscal year. We also provide estimates of a longer run tax base elasticity allowing for the effects of tax rate changes over the current and three prior fiscal years.[19] These longer run elasticities are reported under each city's last column in Table 1. The one-year impact elasticity is most likely measuring a capitalization effect of rate changes on the market values of existing land and structures.[20] The longer run elasticity includes this capitalization effect as well as any effects of rate changes on firm and household investments over the four year period, an adjustment period consistent with other estimates of firm and household investment behaviors; see Caballero, Engel, and Haltiwanger

[19] We have also estimated our model in levels specified as a stock adjustment model. Estimates of the underlying dynamic relationship between base and rates in the stock adjustment specification are consistent with the dynamic relationships estimated here; that is, new equilibrium values of tax base occur quickly, generally within four years. Results available upon request.

[20] There may be some adjustments in firm and housing capital within the city over the initial fiscal year of the rate change. For example, as tax rates rise, firms may be able to relocate or sell existing capital not "bolted" to the plant floor. As tax rates fall, firms and households can undertake new investments in capital -- for example, expand the plant or add a family room. One would expect the one year response of physical capital to rate changes to be larger for rate reductions than for rate increases, given that it should be easier to expand firm and household investment in place than to relocate plant and structures or to disinvest in housing; see Caballero, Engel, and Haltiwanger (1995) and Sinai (1997). To test this hypothesis, the impact elasticities were re-estimated allowing for asymmetric responses of the property base to rate increases and decreases. In each city, the response to rate cuts was larger than the response to rate increases (as expected), but the differences were statistically significant only for Philadelphia. Full estimates are available upon request, but see footnote 21 below.

(1995) and Sinai (1997). The impact elasticities are estimated precisely (t statistics generally ≥ 3.00); the longer-run elasticities are less well estimated and therefore should be interpreted with care. With the exception of Houston, the estimated longer-run elasticities are larger in absolute value than the estimated impact elasticities.

Both Houston and New York City show impact elasticities very close to, or possibly even greater than, -1.0, the point at which the decline in tax base just offsets the added revenues from the increase in tax rates. A balanced budget increase in the local property tax rate from current levels will generate little or no additional net revenues for Houston or, barring large positive effects on other bases (see Table 3), for New York City either. In contrast, Minneapolis and Philadelphia with estimated impact elasticities for property taxation of -.3 and -.4 respectively will be able to raise additional revenues from an increase in local property tax rates. These initial revenue increases do not hold, however, as a rate increase erodes tax base over the next three fiscal years. The longer run tax base elasticities for Minneapolis and Philadelphia are both just over -.7, roughly twice as large as their impact elasticities and not statistically different from -1.0.

Further, the significant negative impact elasticities, when interpreted in the light of the structural model of Figure 1 imply that for the marginal property owners in our sample cities, the property tax rate is too high. An increase in the city's property tax rate offset by a balanced budget increase in public services may shift upward or downward the $V_0(\cdot) = V_0$ indifference curve for residents and the $\Pi_0(\cdot) = 0$ breakeven line for firms. If improved services fail to compensate households and firms for the rate increase, then $V_0(\cdot)$ and $\Pi_0(\cdot)$ shift downward. Rents paid for land and structures in place and thus their capitalized values fall. Under an assumption that the estimated impact elasticities of base with respect to balanced budget changes in tax rates reflect a change in the capitalized values of land and structures in place -- that is, new investment or dis-investment in structures (h) and capital (k) take more than one fiscal year to implement -- then the observed negative elasticities must mean the extra services provided do not compensate either households or firms, or both, for the rate increase. The estimated impact effects in fact allow us to compute the benefit shortfall. Houston, Minneapolis, and Philadelphia property owners are estimated to receive about \$.70 in additional benefits for each \$1 in additional property taxes paid, while New York City property owners are estimated to receive only \$.02 in additional benefits for each \$1 in new property taxes paid.[21] In our sample cities,

[21] From eq. (12) above, the estimated effects of a balanced budget increase in the local property tax rate reflects a capitalization effect of the rate and service changes on market values and any adjustments over the initial fiscal year by firms and households in their holdings of physical capital (k) and structures (h). If firms and households do not change k and h the estimated effect measures only the capitalization effect. This is most likely to be the case for the estimated impact effects and, assuming disinvestment takes more than one year, is probably best estimated by impact effects for rate increases only; see footnote 20. We use the estimates of the impact effect of tax rate increases in our calculations below.

To estimate the additional benefit for each additional dollar of property taxes paid, note that the market value of fixed structures and land will be the discounted present value of market rents -- specified here as $MV = R/r$. Market rents in turn can be approximated by rents paid for the "private" attributes of the property (R_p) plus the value of the public services provided at the location less the property taxes paid on the property: $R = R_p + \upsilon G - T$, where υ is the willingness to pay for G. Finally, assuming a simple linear technology for services $G = \Phi T$, then $R \simeq R_p + [\upsilon\Phi - 1]\cdot T$, and $MV \simeq (R_p/r) + ([\upsilon\Phi - 1]\cdot T/r)$. The expression $[\upsilon\Phi - 1]$ represents the net benefit of a dollar of property taxation. For a small property tax rate change of $\Delta\tau$ applied to the city's current tax base of MV_0, $\Delta T = \Delta\tau \cdot MV_0$. Market values will therefore change by $\Delta MV \simeq ([\upsilon\Phi - 1]/r)\cdot\Delta T$ or by $([\upsilon\Phi - 1]/r)\Delta\tau\cdot MV_0$. Thus $\Delta MV/\Delta\tau = ([\upsilon\Phi - 1]/r)\cdot MV_0$ and, finally, $[\upsilon\Phi - 1] \simeq [\Delta MV/\Delta\tau]\cdot r/MV_0$. Knowing MV_0, r, and using estimates of $[\Delta MV/\Delta\tau]$, we can compute $[\upsilon\Phi - 1]$ and thus $\upsilon\Phi$, the marginal benefit of an additional dollar of property taxation. We assume $r = 3.00$ (τ is measured as a percent in our regressions), MV_0 is set at the sample mean market value for each city, and $[\Delta MV/\Delta\tau]$ is set equal to the estimated impact effect on the city tax base of rate increases only. The estimated impact effect of a property tax rate on city property values (standard errors in parentheses) are: Houston, -5041 (7431); Minneapolis, -3286 (1932); New York City, - 9224 (3542); and new property taxation must be being spent on public services in low demand by the marginal property owner or on transfers to non-property owners (e.g., current and retired public employees or low income residents).[22]

Table 2 provides estimates of the effects of own tax rates on tax base for sales taxation (New York City), gross receipts taxation (Philadelphia), income taxation of residents (New York City), and wage taxation of residents and non-residents (Philadelphia). Increases in both the sales (τ_s) and gross receipts (τ_X) taxes act to reduce their respective tax bases, and the effects are statistically significant (t $\geq$ 3.70). The estimated impact elasticities of base with respect to own rates are about -.60 for New York and -.25 for Philadelphia. Inclusion of lag changes in τ_s and τ_X were never statistically significant and their inclusion had no significant effect on the estimated base elasticities. We conclude the full effect of a change in the gross receipts or the sales tax rate will be felt during the first year of the rate change. The New York City sales tax base fluctuates with swings in the national unemployment rate ($\varepsilon_{s,UE}$ = -.12) around a stable level of real sales per resident (insignificant constant term). Changes in exogenous city aid (ΔZ)

Philadelphia, - 1627 (840). Upon substitution, we estimate $\upsilon\Phi$ = .67 (s.e. = .48) for Houston, $\upsilon\Phi$ = .67 (s.e. = .19) for Minneapolis, $\upsilon\Phi$ = .02 (s.e. = .38) for New York City, and $\upsilon\Phi$ = .70 (s.e. = .15) for Philadelphia. Either $\upsilon < 1$ and average property owner values the services received at less than \$1, or $\Phi < 1$ and the full tax dollar is not allocated to valued services, or both.

[22] Vigdor (1998) obtains similar empirical results for his sample of Massachusetts suburban communities and reaches a similar qualitative conclusion. Given his large cross-section of communities Vigdor then tests for the likely sources of local rent-seeking. He concludes that for his sample of largely suburban communities the most plausible explanation for the negative effect of balanced budget rate increases is a fiscal redistribution from the average to lower valued (median) property owners. For a sample of largely suburban communities, this seems a reasonable result. In our sample of large cities, rent-seeking by public employee unions (Gyourko and Tracy, 1989) or poverty households (Glaeser and Kahn, 1999) are likely to play an important role too.

Table 2: Sales, Gross Receipts, and Income Taxation†

	Sales New York			Gross Receipts Philadelphia			Income/Wage New York			Income/Wage Philadelphia		
	ΔB_s	ΔB_s	ΔB_s	ΔB_X	ΔB_X	ΔB_X	ΔB_w	ΔB_w	ΔB_w	ΔB_{w+m}	ΔB_{w+m}	ΔB_{w+m}
Constant	80.15 (80.59)	25.94 (91.70)	53.19 (88.17)	132.9 (224.4)	472.2 (263.2)	338.5 (211.9)	387.9 (218.4)	447.5 (231.1)	360.7 (218.4)	112.8 (70.30)	71.42 (69.46)	66.46 (74.56)
$\Delta\tau_w$; $\Delta\tau_{w+m}$	—	—	—	—	—	—	−2,658.9* (560.9)	−2,433.5* (581.9)	−2,602.6* (546.1)	−198.3 (253.1)	−166.7 (215.6)	−402.0 (302.8)
$\Delta\tau_w(-1)$; $\Delta\tau_{w+m}(-1)$	—	—	—	—	—	—	—	—	1,034.6 (535.8)	—	—	230.6 (223.7)
$\Delta\tau_w(-2)$; $\Delta\tau_{w+m}(-2)$	—	—	—	—	—	—	—	—	−711.7 (567.1)	—	—	−23.62 (221.6)
$\Delta\tau_s$; $\Delta\tau_X$	−1,275.6* (251.7)	−1,137.4* (272.8)	−1,236.7* (289.3)	−19,477.1* (5,207.0)	−19,955.5* (5,083.4)	−24,453.1* (5,127.7)	—	—	—	—	—	—
$\Delta\tau_s(-1)$; $\Delta\tau_X(-1)$	—	—	141.8 (275.3)	—	—	3,796.5 (5,197.2)	—	—	—	—	—	—
$\Delta\tau_s(-2)$; $\Delta\tau_X(-2)$	—	—	−228.4 (265.6)	—	—	3,332.5 (4,942.4)	—	—	—	—	—	—
ΔUE	—	−158.5 (94.2)	−144.7 (95.7)	—	−293.1 (230.1)	−286.8 (208.7)	—	−251.5 (232.0)	−347.3 (222.7)	—	−152.9* (58.21)	−185.2* (62.96)
ΔZ	—	.39 (.41)	.49 (.44)	—	−4.45 (2.95)	−1.98 (2.57)	—	.14 (1.02)	.15 (1.01)	—	.79 (.76)	.40 (.79)
ΔCRIME	—	.18 (2.94)	—	—	−14.09 (7.58)	—	—	−7.64 (6.98)	—	—	−.32 (1.99)	—
D.W.	2.18	2.14	1.91	1.88	1.50	1.84	2.71	2.63	2.84	1.21	1.35	1.36
$\bar{R}^2$	0.39	0.41	0.40	0.30	0.48	0.54	0.46	0.46	0.53	0.01	0.18	0.23
$\varepsilon_{B,\tau}$	−.61* (.12)	−.55* (.13)	−.63* (.24)	−.25* (.07)	−.25* (.06)	−.22 (.14)	−.84* (.18)	−.77* (.18)	−.72* (.31)	−.06 (.07)	−.05 (.06)	−.06 (.13)
$F(\Delta\tau(-2))$	—	—	.40	—	—	.26	—	—	2.69*	—	—	.41

†Standard errors for each estimated coefficient are reported in parentheses. D.W. is the Durbin-Watson test statistic for serial correlation. $\bar{R}^2$ is the coefficient of determination corrected for degrees of freedom. The elasticity of tax base with respect to tax rates ($\varepsilon_{B,\tau}$) is based on the marginal effects of rates on tax base, calculated for the most recent fiscal year's tax base and tax rate for each city. $F(\Delta\tau(-2))$ is the F statistic testing the null hypothesis that two lagged changes in rates jointly have no influence on change in tax base.

*Coefficient's t statistic ≥ 2.00. New York City's two lagged changes in rates are jointly significant at the .10 level.

and the national rate of violent crimes (ΔCRIME) have no important effects on New York sales tax base. Philadelphia's gross receipts tax base is also sensitive to swings in the national rate of unemployment ($\varepsilon_{X,UE}$ = -.11); here the level of the base shows an upward annual trend (constant term) averaging about 2.7% per annum (.027 = \$472/\$17,707). The Philadelphia gross receipts tax base is affected by the upward trend in the national rate of violent crime; the estimated elasticity $\varepsilon_{X,CRIME}$ is -.46.

New York City's income tax base per resident is sensitive to changes in the city's income tax rates; the estimated impact elasticity of base with respect to changes in the top marginal tax rate is statistically significant and important: $\varepsilon_{B,\tau} \simeq -.84$. The longer-run elasticity is smaller (- . 72) but not statistically different from the impact elasticity; IV estimates reported in Table 4 show an important effect for lagged rates, however. The city's income tax base has been growing at an average annual real rate of 3.46% to 4.29% over our sample period (.0346 = \$360.6/\$10,420 to .0429 = \$447.5/\$10,420). Recessionary periods ($\varepsilon_{w,UE} \simeq -.18$) and the upward trend in the national rate of violent crime ($\varepsilon_{w,CRIME} \simeq$ - .40) have potentially important negative effects on the city's income tax base.

In contrast to New York, Philadelphia's wage tax base per resident shows little overall sensitivity to changes in the city's weighted average wage tax rate on residents and non-residents. The estimated effect of changes in rate on base is small, $\simeq$ -.06, and statistically insignificant. Nor has there been any significant growth over our sample period in the city's real wage tax base per resident, again measured here by the magnitude and statistical significance of the constant term. What does matter for Philadelphia's wage tax base are swings in the national rate of unemployment (UE) ($\varepsilon_{w+m,UE} \simeq -.08$). The small and insignificant base elasticity for the Philadelphia wage tax should not lead to the conclusion that wage tax is without economic consequences. On the contrary, the small base elasticity is the result of two very important but offsetting real-side economic effects. We find below (Table 5) that the city's wage tax drives out jobs and residents in roughly the same proportions, leaving the wage tax base per resident about constant. As an economic and residential center, however, the city is significantly smaller.

Table 3 reports own and cross tax-rate impact (one fiscal year) elasticities for New York City and Philadelphia, based upon a first difference specification including all local tax rates, a constant term, ΔUE, and ΔZ. Only the tax rate elasticities are reported in Table 3. Estimation is by Zellner's SUR procedure, equivalent to OLS in this case. Own impact elasticities from these fully specified regressions are similar in magnitude and statistical significance to those reported in Tables 1 and 2. The estimated cross-elasticities are generally small, negative, and statistically insignificant. The one potentially important exception to this pattern are the estimated *positive* (and almost statistically significant) effects of increases in New York City's income tax rate and the Philadelphia's wage tax rate on each city's property tax base. Figure 1 helps us understand why this might be so. Since residents bear the initial burden of the resident income and wage tax and both residents and businesses benefit from the provision of public goods, $V_0(\cdot)$ is likely to shift downward while $\Pi_0(\cdot)$ rises. If, in Figure 1, $V_0(\cdot)$ is steeply sloped, then the upward shift in $\Pi_0(\cdot)$ can be sufficient to overcome the fall in $V_0(\cdot)$ so that the overall city rents (R^*) and market values rise. $V_0(\cdot)$ will be steeply sloped when city residents strongly value other goods over living space, what we might expect for city

Table 3: Estimated Own and Cross Tax Rate Elasticities†

	New York			Philadelphia		
	B_p	B_s	B_w	B_p	B_X	B_{w+m}
τ_p	−.96*	.04	−.06			
	(.13)	(.06)	(.20)			
τ_s	−.23	−.19*	−.29			
	(.28)	(.07)	(.46)			
τ_w	.25	−.05	−.79*			
	(.13)	(.07)	(.20)			
τ_p				−.57*	.17	−.06
				(.11)	(.13)	(.06)
τ_X				.06	−.39*	.01
				(.05)	(.06)	(.03)
τ_{w+m}				.38	.14	−.04
				(.21)	(.25)	(.12)

†Estimated impact elasticities of each tax base to a corresponding rate change (standard errors in parentheses) are reported for New York City (FY 1959 to FY 1997) and Philadelphia (FY 1970 to FY 1998). Each ΔB equation includes the changes in all three tax rates as well as ΔUE and ΔZ as independent variables. Elasticities are calculated for the most recent fiscal year's tax base and tax rate for each city.

*Estimated elasticity's t statistic ≥ 2.00.

residents.[23]

C. Estimation: Robustness

Table 4 provides two checks of the robustness of our core results, first to the inclusion of possibly important exogenous economic "shocks" which may affect both tax base and tax rates and then, second, to the possible endogeneity of local tax rates. Failure to control for either local economic shocks or for the endogeneity of local tax rates may bias our estimated elasticities. Our analysis here uses ΔB regressed against $\Delta\tau$, ΔUE, and ΔZ as a core specification, but then adds city specific "Shock" variables to control for possible omitted variable bias. Appendix B provides the first-stage estimates of local tax rates for our IV estimation; instruments include exogenous political and regulatory events likely to influence local tax rates but not local tax base, at least directly.[24]

For Houston, we measure local economic shocks by the change in a four-year moving average of the annual refiners' real (1994) price per barrel of domestic crude oil (ΔFUEL), reported in Table 4 as "Shocks". Increases in the four year price of crude oil increases

[23] Haughwout and Inman (2000) explore this argument more completely and show formally that for plausible parameterizations of the city economy income tax rate increases can increase city property values in equilibrium.

[24] The formal model also specifies a roles for the costs of local public goods (c: measured by changes in the national industrial producer price index), the interest rate faced by firms and households (r: measured by the AAA corporate borrowing rate) and the non-resident wage (m: measured by national average hourly earnings in non-agricultural industries). As additional sensitivity tests, we did include Δc, Δr, and Δm in each of the core tax base equations of Tables 1 and 2. In most instances they had their expected signs in the ΔB equations (- for Δc for all bases; - for Δr for the property base, ambiguous for sales and income; ambiguous for Δm in all base equations), but the estimated effects were only significant for Δc in the Philadelphia property base equation ($\varepsilon_{p,c}$ = -.62) and Δm in the two income tax base equations ($\varepsilon_{w,m}$ = .95 for New York and $\varepsilon_{w+m,m}$ = .80 for Philadelphia). Full results are available upon request.

Table 4: Sensitivity Analysis

	Houston	Minneapolis	New York			Philadelphia		
	ΔB_p	ΔB_p	ΔB_p	ΔB_s	ΔB_w	ΔB_p	ΔB_X	ΔB_{w+m}
Economic Shocks†								
$\Delta\tau_p$	−13,782.6* (5,603.8)	−2,921.8* (718.6)	−11,108.6* (1,544.0)	—	—	−3,507.4* (540.0)	—	—
$\Delta\tau_s, \Delta\tau_X$	—	—	—	−1,152.3* (279.2)	—	—	−19,179.6* (5,399.4)	—
$\Delta\tau_w, \Delta\tau_{w+m}$	—	—	—	—	−2,635.1* (573.6)	—	—	−178.9 (226.3)
"Shocks"	720.2* (284.8)	1,556.1* (422.5)	−.62 (.74)	.04 (.19)	.85 (.54)	7.45* (2.32)	1.34 (4.74)	−.72 (11.20)
$\varepsilon_{B,\tau}/\varepsilon_{B,\tau}^{LR}$	−.92* (.37)	−.37*/−.50* (.09) (.22)	−.94* (.13)	−.49* (.12)	−.84*/−.68* (.18) (.29)	−.46*/−.77* (.07) (.21)	−.24* (.07)	−.05 (.06)
IV Estimates††								
$\Delta\tau_p$	−18,895.5* (7,483.9)	−1,626.5 (920.6)	−8,233.2* (2,125.6)	—	—	−2,377.8* (1,006.2)	—	—
$\Delta\tau_s, \Delta\tau_X$	—	—	—	−1,647.3* (285.2)	—	—	−30,714.0* (6,682.5)	—
$\Delta\tau_w, \Delta\tau_{w+m}$	—	—	—	—	−2,615.4* (628.5)	—	—	−223.4 (274.3)
$\varepsilon_{B,\tau}/\varepsilon_{B,\tau}^{LR}$	−1.27* (.50)	−.20/−.61* (.12) (.23)	−.70* (.18)	−.79* (.13)	−.83*/−.63* (.19) (.31)	−.31*/−.69* (.18) (.34)	−.39* (.08)	−.07 (.08)

†Economic shocks are measured by the annual change in the four-year, moving average price for domestic crude oil for Houston (ΔFUEL); the seven years of exogenous state funded economic development and sports stadium construction in downtown Minneapolis (1982–1988; STADIUM); the annual change in the real value of the Dow Jones industrial average for New York City (ΔDOW), and the annual change in the real level of national personal health care expenditures for Philadelphia (ΔHEALTH). Also reported for Minneapolis property taxation, New York City income taxation, and Philadelphia property taxation are the "longer-run" tax base elasticities estimated with the inclusion of lagged tax rates and these cities' economic shock variables. The longer-run elasticities are reported after the single period elasticity (standard errors in parentheses).

††IV estimates based upon instrumental variables estimation of each city's tax rates; see Appendix B. The IV estimation equations include each city's economic shock: ΔFUEL (Houston), STADIUM (Minneapolis), ΔDOW (New York City), and ΔHEALTH (Philadelphia). The New York City and Philadelphia estimates also allow for cross-equation correlation of error terms. Also reported for Minneapolis property taxation, New York City income taxation, and Philadelphia property taxation are the "longer-run" tax base elasticities estimated with the inclusion of IV estimated lagged tax rates. The longer-run elasticities are reported after the single period elasticity (standard errors in parentheses).

*Coefficient's t statistic ≥ 2.00. Standard errors for each estimated coefficient are reported in parentheses.

Houston's property base with an estimated elasticity of base with respect to FUEL of .24 (s.e. = .09). With the inclusion of ΔFUEL, the estimated elasticity of tax base with respect to tax rate falls from -1.17 to -.92; compare Tables 1 and 4. To control for the potential endogeneity of Houston's local property tax rate we re-estimated the core base equation using a predicted value of local tax rates to estimate $\Delta\tau_p$; see Appendix B. Our instrumental variables (IV) estimate of $\varepsilon_{B,\tau}$ for the core specification including ΔFUEL is -1.27 (s.e. = .50); see Table 4. Overall, our OLS and IV estimates of $\varepsilon_{B,\tau}$ are all near, or exceed, -1, suggesting Houston is at, or over, the top of its property tax revenue hill.

For Minneapolis, we included as our measure of a local economic shock an indicator variable (STADIUM) equal to 1 for the seven years of state funded downtown economic development, including the construction of the Hubert H. Humphrey Metrodome and the Minneapolis Convention Center, 0 otherwise; see "Shocks" in Table 4. For each of those seven years, the city's property tax base gained an average of $1556/resident for a total increase in value of $10,892/resident (= 7 x $1556). Interestingly, this estimated growth in property values over this seven year period accounts for *all* the real growth in the city's tax base over our 24 year sample period; Minneapolis's property base would have been stagnant in real terms without this state intervention. Including the indicator variable STADIUM has no significant effect on the impact base-to-rate elasticity but it does reduce our estimate of the longer-run elasticity from -.72 (Table 1) to -.50 (Table 4). The IV estimates for the Minneapolis property tax equation (now including STADIUM) show some evidence of possible simultaneity bias as well; the impact elasticity falls from -.37 (Table 4) to -.20 (Table 4). The longer-run elasticity is not affected by IV estimation.

For New York City, the annual change in the real (1994) value of the Dow-Jones Industrial Average (ΔDOW) was added to each of the core tax base equations to measure the possible influence of the city's financial sector on tax base; see "Shocks" in Table 4.[25] ΔDOW was marginally significant only in the city's income tax base equation ($t = 1.57$), where the estimated elasticity of base with respect to the DOW is .18. Adding ΔDOW to the base equations had no important effects on our estimated tax base elasticities; compare Tables 1 and 2 to Table 4. What does make a difference to our estimates of the city's base-to-rate elasticities is allowing for the potential endogeneity of local tax rates. The IV estimates (including ΔDOW) are reported in Table 4. With IV estimation, the property tax base elasticity falls from -.94 (OLS; Table 4) to -.70 (IV; Table 4), while the sales tax base elasticity rises from -.49 (OLS; Table 4) to -.79 (IV; Table 4). The impact and longer-run income tax base elasticity estimates are robust to IV estimation, -.84 (OLS; Table 4) vs. -.83 (IV; Table 4) and - .68 (OLS; Table 4) vs. - .63 (IV; Table 4), respectively.

For Philadelphia, whose current economy is closely tied to the national health care sector, we included the annual change in real (1994) national health care expenditures (ΔHEALTH) as a measure of a local economic shock. The variable is statistically significant in the property tax base equation only; see "Shocks" in Table 4. The elasticity of the city's property base with respect to changes in national health spending is .63 (s.e. = .22). There are no important effects

[25] We also included an indicator variable in income tax base equation called FedReform equal to 1 for the fiscal year after the passage of the 1986 Tax Reform Act. The 1986 federal tax reforms broadened the federal tax base and potentially the New York City income tax base as well. The estimated coefficient for FedReform was 822.4 (s.e. = 1612.9) implying an increase in base of about 8 percent. The inclusion of FedReform had no important effects on our estimates of $\varepsilon_{B,\tau}$ for income taxation.

of including ΔHEALTH on our estimates of Philadelphia's base-to-rate elasticities; compare Tables 1 and 2 with Table 4. IV estimation (including ΔHEALTH) lowers the property tax base elasticities both in the short run -- from -.46 (OLS; Table 4) to -.31 (IV; Table 4) -- and the longer run -- from -.77 (OLS; Table 4) to -.69 (IV; Table 4), but the gross receipts tax base elasticity rises from -.24 (OLS; Table 4) to -.39 (IV; Table 4). Wage tax base elasticity is unaffected by IV estimation.

Two further sensitivity tests were performed. During our sample period both Connecticut and New Jersey introduced personal income taxes for state residents, two "policy shocks" with possibly favorable effects on the tax bases for New York City and Philadelphia. We included in each tax base equation an indicator variable equal to 1 for the year in which New Jersey (1976) and (for New York City only) Connecticut (1991) introduced a personal income tax. There were no significant effects of these out-of-state tax reforms on the income or sales tax bases of either city. There were, however, statistically significant and economically important effects on both cities' property tax bases, felt fully within the first year of the reform. The reforms had no significant effects on the changes in the property tax base beyond the year of their introductions, supporting an interpretation of these estimated effects as fiscal capitalization. The introduction in New Jersey of a state income tax in 1976 raised New York City's property values by $4989/resident in 1977 (s.e. = 1740), while the adoption by Connecticut of their income tax in 1991 raised New York City property values in 1992 by $5347/resident (s.e. = 1796). The estimated coefficients imply the capitalization of from 22 percent (Connecticut reform) to 38 percent (New Jersey reform) of the state income tax differentials into City property values. The effect of the New Jersey income tax on the Philadelphia property tax base is also statistically significant, increasing average city values by \$2330/resident (s.e. = 1014). The implied rate of capitalization of state tax differences into Philadelphia property values is 17 percent. The different rates of capitalization can most likely be attributed to differences in the demand for land by businesses in the two city economies.[26] For neither city did the inclusion

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[26] The introduction of a new tax on households (without compensating services) by the city's competitive political jurisdictions makes those jurisdictions less attractive. This raises V_0 in Figure 1. For a given Π_0 schedule, R^* therefore rises. Thus new taxes in neighboring jurisdictions will be capitalized back into city values ($= R^*/r$). For comparable upward shfits in V_0, the observed increases in R^*/r allows us to identify the relative slope of the Π_0 schedule. A city with a business sector for which land is relatively (un)important in production will have a relatively (steep) flat Π_0 schedule; see Haughwout and Inman (2000).

For New York City, the 1976 New Jersey income tax introduced a progressive tax on resident income with rates ranging from 1.5 to 3 percent. An average 1976 family considering living in New York or New Jersey had an annual income of approximately \$40,000 per family in 1994 dollars. This family's faced a new Jersey state income tax rate of approximately 3 percent. They will therefore pay an additional \$1200/year in taxes; this provides an income equivalent estimate of the maximal upward shift in V_0. If the Π_0 schedule is very steep, R^* will rise roughly \$1200/year as well. Capitalizing this maximal increase in R^* at a real interest rate of .03 per annum implies an maximal increase in the value of city land and structures of about \$40,000 (= \$1200/.03) per "parcel" or about \$13,333/resident (assuming three residents per family). The estimated increase in value is \$4989/resident following the introduction of the New Jersey income tax. Actual capitalization is therefore 37 percent of maximal capitalization. In Figure 1, the Π_0 schedule for New York City must be "moderately" negatively sloped. A similar calculation for the introduction of the Connecticut income tax gives a similar result. The 1991 Connecticut income tax rate was 1.5 percent but was understood to rise to 4 percent in 1992. For a New York City or Connecticut family with the average income of \$55,000 (1994 dollars) we use the expected tax rate of 4 percent and an implied tax burden of \$2200/year -- again a rough estimate of the upward shift in V_0. For a very steep Π_0 schedule, the maximal increase in R^* would therefore be \$2200/year. Capitalized at .03 per annum implies an increase in value of city land and structures of \$73,333 or \$24,444/resident (assuming three residents per family). The estimated increase in value is \$5347/resident following the introduction of the Connecticut income tax. In 1991 for the Connecticut income tax increase, the actual capitalization is estimated to be 22 percent of maximal capitalization. Again we conclude Π_0 is moderately negatively sloped, and perhaps flatter (land becoming more important in business production) than it was in 1976.

For Philadelphia, we also assume a typical family choosing between Philadelphia and New Jersey in 1976 had an annual family income equal to \$40,000 in 1994 dollars. New New Jersey income taxes will again equal \$1200 per year. Assume V_0 rises by this amount. If Π_0 is very steep, then maximal capitalization into rents (R^*) will occur, and, as above, will equal of these policy shocks have important effects of the estimated base-to-rate elasticities.

Our final sensitivity test adds to each tax base equation an indicator variable equal to 1 for the mayoral regimes of the nationally prominent mayors in our sample cities. Controlling for the fiscal policies of the city and its core economic environment, does the national prominence of a city's mayor enhance or hurt city tax bases? We tested this proposition sequentially for Mayors Koch, Dinkins, and Giuliani of New York City and Mayors Rizzo and Rendell of Philadelphia. For only one mayor was the mayoral indicator variable statistically significant: Mayor Rizzo cost the Philadelphia wage tax base an average of -\$282/resident per year (s.e. = 122) over his eight years in office (about 2.1 percent of average city wages). With this one exception, it has been the fiscal policies of the cities' mayors, not the mayor's reputation, managerial style or personality, which has determined city tax bases.

D. Estimation: Taxes and City Jobs

As a further test of the underlying model and tax base specification, Table 5 provides evidence of the effects of changes in city taxes, and associated public spending, on the one dimension of the real economy we can measure with annual time series data: city jobs. The *Bureau of Labor Statistics*' annual employment series are available by county. For New York City (composed of five counties) and Philadelphia (a city-county) a time series of employment corresponding to the city's political jurisdiction can be constructed. This is not possible for Houston or Minneapolis. Results are presented for changes in each city's share of national total

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\$40,000 per parcel or \$13,333/resident. For Philadelphia, the estimated increase in value is \$2330/resident following the introduction of the New Jersey income tax. Thus actual capitalization is 17 percent of maximal capitalization. We conclude that the Π_0 schedule in Philadelphia in 1976 is negatively sloped, and flatter (land more important) than was the corresponding 1976 Π_0 schedule in New York City.

Table 5: Taxation and Job Location[†]

	New York City (1970–1997)				Philadelphia (1971–1998)			
	Δ Total Job Share (OLS)	Δ Total Job Share (IV)	Δ Manu Job Share (IV)	Δ Service Job Share (IV)	Δ Total Job Share (OLS)	Δ Total Job Share (IV)	Δ Manu Job Share (IV)	Δ Service Job Share (IV)
Constant	−.00076	−.00077	−.00071*	−.00010	−.00027*	−.00023*	−.00024*	−.00023*
	(.00043)	(.00044)	(.00020)	(.00048)	(.00005)	(.00005)	(.00006)	(.00005)
$\Delta\tau_w; \Delta\tau_{w+m}$	−.00065*	−.00070*	−.00089*	−.00060*	−.00030*	−.00033*	−.00032*	−.00032*
	(.00022)	(.00024)	(.00028)	(.00029)	(.00011)	(.00012)	(.00015)	(.00010)
$\Delta\tau_w(-1); \Delta\tau_{w+m}(-1)$	−.00057*	−.00067*	−.00083*	−.00047	−.00031*	−.00037*	−.00036*	−.00035*
	(.00021)	(.00024)	(.00028)	(.00029)	(.00009)	(.00011)	(.00015)	(.00011)
$\Delta\tau_w(-2); \Delta\tau_{w+m}(-2)$	−.00041*	−.00047*	−.00067*	−.00018	−.00009	−.00025*	−.00036*	−.00016
	(.00019)	(.00021)	(.00027)	(.00025)	(.00007)	(.00009)	(.00012)	(.00010)
ΔZ	$.45 \times 10^{-6}$	$.39 \times 10^{-6}$	$.26 \times 10^{-6}$	$.15 \times 10^{-6}$	$-.22 \times 10^{-6}$	$-.26 \times 10^{-6}$	$-.50 \times 10^{-6}$	$-.09 \times 10^{-6}$
	$(.24 \times 10^{-6})$	$(.25 \times 10^{-6})$	$(.34 \times 10^{-6})$	$(.30 \times 10^{-6})$	$(.27 \times 10^{-6})$	$(.28 \times 10^{-6})$	$(.38 \times 10^{-6})$	$(.31 \times 10^{-6})$
ΔDOW	$.26 \times 10^{-6}$	$.25 \times 10^{-6}$	$.31 \times 10^{-6}$	$.28 \times 10^{-6}$	—	—	—	—
	$(.21 \times 10^{-6})$	$(.21 \times 10^{-6})$	$(.25 \times 10^{-6})$	$(.25 \times 10^{-6})$				
ΔHEALTH	—	—	—	—	$.78 \times 10^{-6}$	$.55 \times 10^{-6}$	$.37 \times 10^{-6}$	$.43 \times 10^{-6}$
					$(.49 \times 10^{-6})$	$(.44 \times 10^{-6})$	$(.58 \times 10^{-6})$	$(.47 \times 10^{-6})$
D.W.	1.25	1.33	1.74	1.22	1.83	1.91	1.74	2.01
$\bar{R}^2$	.75	.74	.60	.68	.54	.60	.58	.40
$\varepsilon_{N+M,\tau}$	−.06*	−.08*	−.15*	−.07*	−.12*	−.19*	−.24*	−.17*
	(.02)	(.03)	(.05)	(.03)	(.06)	(.06)	(.11)	(.06)
$\varepsilon^{LR}_{N+M,\tau}$	−.17*	−.22*	−.40*	−.14*	−.31*	−.54*	−.78*	−.45*
	(.05)	(.07)	(.10)	(.07)	(.12)	(.12)	(.25)	(.11)
$F(\Delta\tau(-2))$	4.18*	4.18*	4.11*	1.50	4.65*	4.65*	2.47*	5.76*

[†]Standard errors for each estimated coefficient are reported in parentheses. D.W. is the Durbin-Watson test statistic for serial correlation. When appropriate, estimation corrected for a first-order autoregressive process. $\bar{R}^2$ is the coefficient of determination corrected for degrees of freedom. The elasticity of city jobs with respect to changes in the city income or wage tax rate is calculated for the first year of the new tax rate as the "impact" elasticity ($\varepsilon_{N+M,\tau}$) and as the "long-run" elasticity after three fiscal years of the new tax rate ($\varepsilon^{LR}_{N+M,\tau}$). All elasticities are calculated at sample means. $F(\Delta\tau(-2))$ is the F statistic testing the null hypothesis that two lagged changes in rate have no influence on change in job share; the test was computed for the original OLS specification.

*Coefficient's t-statistic ≥ 2.00. New York City's two lagged changes in rates are jointly significant at .05 in the Total and Manufacturing equations. Philadelphia's two lagged changes in rates are jointly significant at .05 (Total and Service) and .10 (Manufacturing).

employment, of national "manufacturing" employment (= manufacturing + construction + communications + public utility + transportation employment), and of national "service" employment (= FIRE + retail + wholesale + services + federal and state government employment). The constant term from each equation provides an estimate of the secular trend in the each city's share of national jobs, holding fiscal policy constant. Changes in τ and Z measure the effects on jobs of tax and aid financed changes in public spending, respectively. For each city, we estimated the effects of changes in each of the three local tax rates -- property, sales (New York) or gross receipts (Philadelphia), and income (New York) or wage (Philadelphia) -- on changes in city employment shares. Only changes in New York City's income tax rate (measured as the top marginal rate) and Philadelphia's wage tax rate (measured as the weighted average of resident and non-resident rates) showed statistically significant and quantitatively important impacts on city shares of national jobs.[27] These are the results reported in Table 5, where we highlight the IV estimates. (See Appendix B for instruments.) Income and wage tax rate changes longer than three fiscal years ago (current plus two lags) were never statistically significant; F test statistics for the significance of two lagged rates based upon the OLS estimates are reported for each specification in Table 5. Specifying city jobs as a share of national jobs proved an adequate control for swings in the national economy; ΔUE had no important added effect on city job shares. ΔDOW and ΔHEALTH are also included to measure

[27] We tested for the effects of changes in each tax rate alone and jointly with changes in the income or wage tax rates. While the effect of rate changes were generally negative on job shares, only for the Philadelphia property tax rate in the total employment and manufacturing employment equations did the effect reach even marginal statistical significance (t = 1.4). The implied long-run elasticities of Philadelphia jobs with respect to changes in Philadelphia property tax rates were -.20 for total jobs and -.15 for manufacturing jobs. Results available upon request.

the effects on city job shares of national shocks with possibly important local effects. Table 5 reports the implied impact ($\varepsilon_{N+M,\tau}$) and longer-run ($\varepsilon^{LR}{}_{N+M,\tau}$) elasticities of jobs to current period and to lagged changes in the city tax rates. For both New York City and Philadelphia local taxes matter for city jobs, particularly so for what we have classified as manufacturing jobs. Our estimated elasticities for New York City and Philadelphia are consistent with results obtained in other studies of the effects of taxes on jobs; see Bartik (1991; Appendix 2.2) for a survey.

In 1970 New York City had 5.28 percent of the nation's jobs; today (1997) the city's share is 2.81 percent. As demonstrated by the negative constant terms in each of New York City's employment share equations there has been a steady secular trend away from city jobs, with a greater rate of decline in the city's share of the national manufacturing as opposed to service sector jobs. Compounding the secular loss in jobs share have been increases in the city's income tax rates over the past thirty years, rising from a top marginal rate of 2.00 percent to today's 4.46 percent. The OLS estimates in Table 5 show a statistically significant negative effect of these rate increases on job share; the IV estimates are less precise but of comparable magnitude. For New York City, the adverse effect of rising rates on city jobs is almost entirely due to the negative impact of city taxes on the manufacturing sector; see Table 5. In contrast, there appears to have been only a small adverse effect of city taxes on the city's share of national service sector jobs; again, see Table 5. Of the total decline in New York City's share of national jobs over the past three decades, approximately 16 percent of the decline can be attributed to the rise in the city's income tax rates. This implies a loss of 492,000 city jobs from

1970 to 1997 because of increases in the city's income tax.[28]

Philadelphia's share of national jobs has declined from 1.24 percent in 1971 to .54 percent by 1998. As in New York City, the negative constant term in the share equations shows a secular trend away from the Philadelphia economy, a trend affecting the manufacturing and service sectors about equally. But also as in New York City, the rise in the city's labor tax rate, here the weighted average wage tax rate, from 3.00 percent in 1971 to a peak of 4.765 percent in 1995 has been a major contributor to the fall in city jobs. Since 1996, the wage tax rate has been reduced to its current (1998) average rate of 4.6025 percent. The OLS and IV estimates of Table 5 both show statistically significant negative job effects of rising city wage tax rates; the effects are felt in both the manufacturing and service sectors. Again, we can use the estimates in Table 5 to allocate responsibility for the loss in city jobs. Of the total decline in Philadelphia's share of national jobs over the sample period, approximately 21 percent of the decline can be attributed to the secular rise in the city's wage tax rates. The estimated number of city jobs lost because of tax rate increases over this period is 206,500. Mayor Rendell's tax cuts begun in FY 1996 had restored approximately 11,800 jobs by the end of FY 1998.[29]

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[28] To calculate the contribution of New York City tax increases to the decline in the city's share of national jobs we first estimated the difference in the city's predicted job share with actual tax rate changes and the city's predicted job share with no tax rate changes. This difference in job shares equals .40 percent, or about 16 percent of the actual decline in shares (= .40/(5.28 - 2.81)). The total number of jobs lost over this period because of rising taxes is estimated as the change in job share due to tax increases times national jobs in 1997: 491,661 = $.004 \cdot 122.915$ million jobs.

[29] To calculate the contribution of Philadelphia tax increases to the decline in the city's share of national jobs we first estimated the difference in the city's predicted job share with actual tax rate changes and the city's predicted job with no tax rate changes. For Philadelphia, this difference equals .15 percent, or about 21 percent of the actual decline in shares (= .15/(1.24 - .54)). The total number of jobs lost over this period because of the secular rise in

For both New York City and Philadelphia, Table 5 shows it has been the secular trend against each city's economy coupled with rising city income or wage tax rates which explain a significant fraction of the exodus of jobs from the city. There is nothing these two cities can do about the secular trend, but balanced budget reductions in the city's tax rates can slow decline, as has happened recently in Philadelphia. Of course, these rate reductions will cost city tax revenues and, without efficiency gains, city services. The analysis here can provide estimates of the revenue costs of each new job gained from cutting tax rates. Using 1997 values for income tax revenues and total city jobs we estimate that for New York City the annual revenue loss per new city job to be \$2405/job per year or, since rate reductions must be permanent to be credible, a present value cost \$80,167/job assuming a real discount rate of .03. Similar estimates for permanent reductions in the Philadelphia's wage tax rate, evaluated at 1998 wage tax revenues and rates imply an annual revenue cost per new city job of \$2707/job per year or, for a permanent tax cut, a present value cost of \$90,229/job.[30] Tax cuts, while not sufficient

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wage taxes is estimated as the estimated change in job share due to tax increases times national jobs in 1998: 194,719 = .0015 · 129.813 million jobs. The Rendell tax cut is estimated to have restored .009 percent to the Philadelphia job share or 11,775 jobs (= .009 · 129.813 million jobs) by 1998.

[30] The marginal revenue costs of a new job can be estimated as ΔRevenue/ΔJobs, where $\Delta\text{Revenue} = \text{Revenues} \cdot (1 + \varepsilon^{LR}{}_{B,\tau}) \cdot (\Delta\tau/\tau)$ and where $\Delta\text{Jobs} = \text{Jobs} \cdot \varepsilon^{LR}{}_{N+M,\tau} \cdot (\Delta\tau/\tau)$. Since we use the base-adjusted long-run elasticities to estimate the effects of rate reductions on revenues, the estimates of revenue costs will be net of the additional revenues made available by the new jobs. Using New York City's 1997 values for income tax revenues (= \$672/resident) and city jobs (= .47 jobs/resident), and the IV estimates for $\varepsilon^{LR}{}_{B,\tau}$ (= -.63; Table 4) and $\varepsilon^{LR}{}_{N+M,\tau}$ (= - .22; Table 5), we estimate the annual revenue loss per new City job to be - \$2405/job. The present value of these annual revenue costs will be equal to \$80,167/job (= \$2405/.03) assuming a 3 percent real rate of interest. Using Philadelphia's 1998 values for wage tax revenues (=\$723/resident) and city jobs (.46 jobs/resident) and the IV estimates for $\varepsilon^{LR}{}_{B,\tau}$ (= -.07; Table 4) and $\varepsilon^{LR}{}_{N+M,\tau}$ (= -.54; Table 5), we estimate the annual revenue loss per new City job to be -\$2707/job. For Philadelphia, the present value of these annual costs will be equal to

by themselves to reverse the long-run secular trends against the New York and Philadelphia economies -- rates can only fall so far -- will at least slow the city's relative rate of economic decline and provide increased employment opportunities for city residents. As a "jobs program" for inner city residents, however, the tax cut strategy appears more costly than programs which train and place residents directly in city or suburban jobs; see Heckman (1999). Elected city officials must decide whether the private benefits of new city jobs are worth these public costs of lower taxes and any resulting decline in city services.

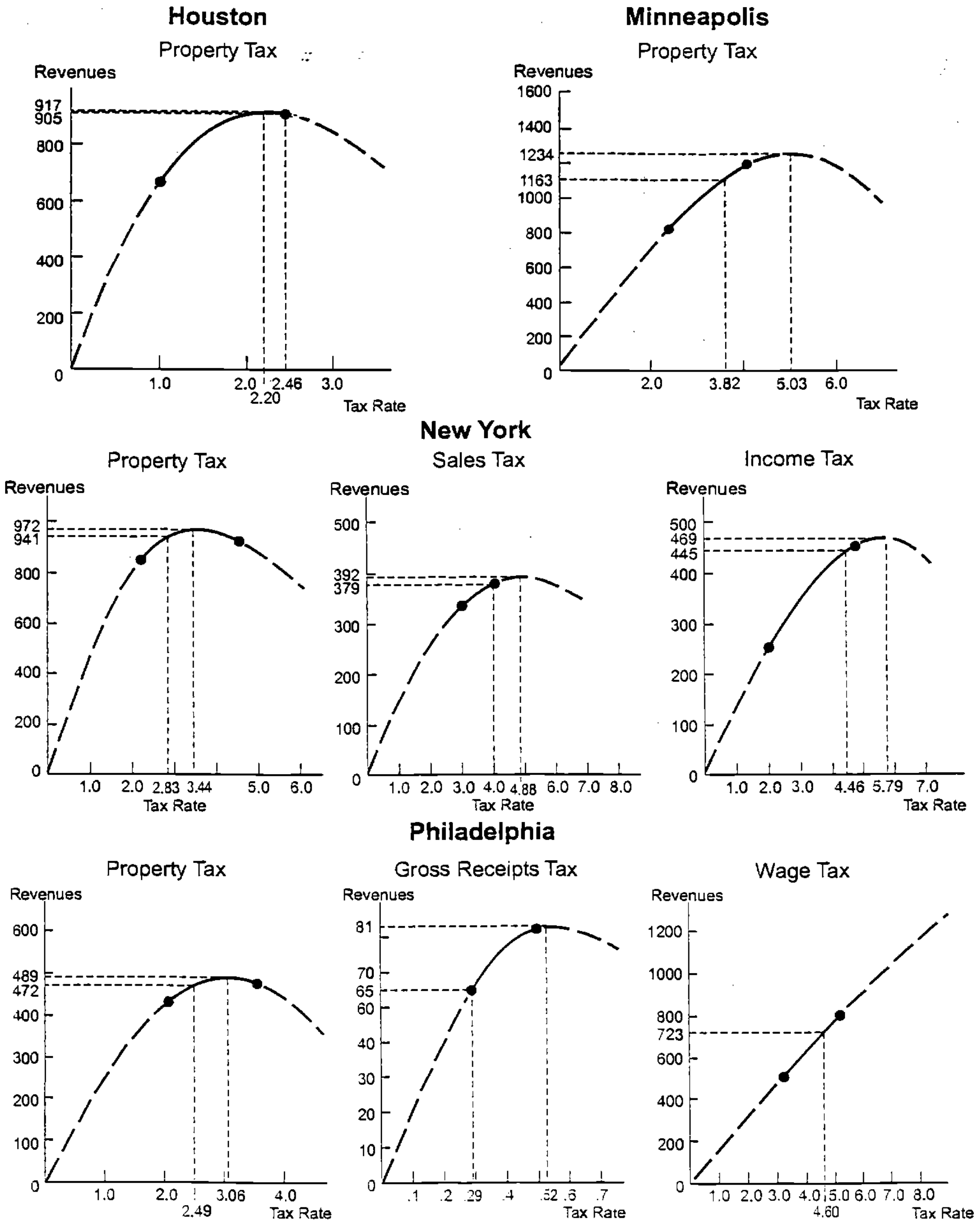
IV. Revenue Hills

Figure 2 presents estimates of each city's longer-run revenue hills for increases in city tax rates from the city's current (last year of our sample) tax rate and revenue location. Each city's revenue hills were simulated based upon the IV estimates including economic shocks reported in Table 4.[31] Four general conclusions emerge from the analysis in Figure 2.

\$90,229/job (= \$2707/.03).

[31] Each revenue hill is estimated by the relationship Revenue $= \tau_0 \cdot B_0 + \Delta\tau \cdot B_0 + \tau_0 \cdot \Delta B + \Delta\tau \cdot \Delta B$, where τ_0 and B_0 are the actual tax rates and tax base for the last year of our sample, $\Delta\tau$ is the change in tax rate from τ_0 to each new tax rate along the horizontal axis and ΔB is the predicted equilibrium change in base for each $\Delta\tau$ using the IV estimates reported in Table 4. For Minneapolis and Philadelphia property taxation and for New York City income taxation the lagged effects of changes in rate on base are included when estimating ΔB. (These IV point estimates are not given in Table 4 but are available upon request.) Finally, to estimate New York City's income tax revenue hill, τ_0 and $\Delta\tau$ are the tax rates for the average income household; however, ΔB is estimated from changes in the top marginal rate. We assume the average rate is linked to the top marginal rate through a simple proportional relationship, estimated from the data in our sample. Consistent with our model specification, the top marginal rates are reported on the horizontal axis of Figure 2, New York City, Income Tax.

Figure 2: City Revenue Hills*



*Revenue hills are based on estimated IV tax base elasticities as reported in Table 4. The solid lines between dots represent the portion of the hill which spans the sample range for city tax rates; the long dashed portions of each hill are projections beyond the sample's range.

First, with the exception of the Philadelphia wage and gross receipts tax, our sample cities are very near, or in the case of Houston's property tax over, the top of their local revenue hills. The current (1997) Houston property tax rate is 2.46% and current revenues are \$905/resident; the revenue-maximizing rate, however, is 2.20% and maximal (1997) revenues are \$917/resident. Minneapolis is on the rising portion of its longer-run property tax revenue hill, but the "summit" is flat and available additional revenues are modest. Minneapolis' current (1997) rate of 3.82% raises \$1163/resident while going to the maximal rate of 5.03% adds only an additional \$71/resident to \$1234/resident. All three of New York City's taxes are now near their maximal revenue potentials as well. The property tax can generate an additional \$31/resident (= \$972/resident - \$941/resident) by increasing the rate from its current (1997) 2.83% to 3.44%; the sales tax an additional \$13/resident (= \$392/resident - \$379/resident) by increasing its rate from 4.00% to 4.88%; and the income tax an additional \$25/resident (\$469/resident - \$445/resident) by increasing its top bracket rate (and all other rates proportionally) from 4.46% to 5.79%.

Philadelphia is the only city in our sample with an ability to raise significant additional revenues per resident from local taxes, in this case from the local wage tax. Like our other cities Philadelphia's property tax shows little new revenue potential; increasing its rate from the current (1998) 2.49% to a maximal longer-run rate of 3.06% will yield only \$17/resident (= \$489/resident - \$472/resident) in new monies. The city's gross receipts tax is a small revenue source generally and can raise only an additional \$16/resident (\$81/resident - \$65/resident) from increasing its rate from the current (1998) .29% to the maximal rate of .52%. As Figure 2 shows, however, the city's wage tax can generate significant new revenues per capita. But any mayor adopting this strategy wins a Pyrrhic victory; raising the city's wage tax rate leads to significantly fewer jobs (Table 5) and most likely fewer residents as well.[32] Both candidates in the recent mayoral race in Philadelphia understood this point. An increase in the Philadelphia wage tax rate now appears off limits politically because of its strong adverse effects on the size of city's real economy.

Second, in both Minneapolis and Philadelphia we observe statistically significant and quantitatively important differences between the one-year (impact) response and the longer-run (equilibrium) response of the city's property tax bases to rate changes; the longer-run negative response is larger. The peaks of the short-run property tax revenue hills (not shown in Figure 2) occur well beyond the peaks of Figure 2's longer-run hills. The peak of the Minneapolis short-run revenue hill occurs at a tax rate of 11.27% and maximal revenues are $2064/resident. The peak of the Philadelphia short-run property tax revenue hill occurs at a rate 5.22% and maximal revenues are $649/resident. For a mayor to aggressively pursue these short-run

[32] A direct estimate of the effects of city taxes on city population is not possible since all annual population series available are unlikely to measure population variations with much accuracy. Still, simple arc elasticities between census years can be calculated to provide an order of magnitude estimate for the effects of tax rates on population. Given the central importance of the wage tax to city jobs, we assume the wage tax is the most important tax driving residents from Philadelphia. The simple arc elasticity of population with respect to the average wage tax rate is - .37 for the decade 1970 to 1980 and -.63 for the decade 1980 to 1990. A trend controlled estimate of the elasticity of city population with respect to wage tax rates can be computed from the identity for the wage tax base ($B \equiv w \cdot (N+M)/POP$) and the corresponding identity among elasticities: $\varepsilon_{B,\tau} \equiv \varepsilon_{w,\tau} + \varepsilon_{N+M,\tau} - \varepsilon_{POP,\tau}$. Our work provides trend controlled estimates of $\varepsilon_{B,\tau}$ (-.07; Table 4), $\varepsilon_{w,\tau}$ (-.20; an IV estimate of the effect of rates on the average wage; available upon request), and $\varepsilon_{N+M,\tau}$ (= -.54; Table 5). These estimates imply $\varepsilon_{POP,\tau} = -.67$. Both the simple arc elasticity estimates and the trend-controlled elasticity imply a strong negative effect of wage taxes on city population for Philadelphia. This makes sense given that the only way to fully escape both the resident *and* non-resident portions of the tax is to move your job *and* your residence outside the city.

revenues may lead his city into the unproductive range of the longer-run revenue hill, however; see Inman (1989). It appears the current Minneapolis and Philadelphia mayors have avoided this temptation, at least for now, keeping their cities on the rising portion of their property tax revenue hills.

Third, while our cities are near the tops of their revenue hills, jumps in tax base will shift the hills upward and provide additional revenues at stable rates. There are two possible sources for base increases: annual tax base growth and favorable economic shocks (ΔFUEL, STADIUM, ΔDOW, and ΔHEALTH > 0). The annual growth in city tax bases is estimated by the constant terms in each ΔBASE equation; multiplying the growth in base by the revenue maximizing tax rate provides an estimate of the maximal potential growth in annual revenues. For Houston the (IV) estimated maximal growth in revenues is \$8.95/resident per year (s.e. = 15.75); for Minneapolis maximal revenue growth is \$6.71/resident per year (s.e. = 14.80); for New York City maximal aggregate revenue growth is \$23.56/resident per year (s.e. = 12.10); and for Philadelphia maximal revenue growth is -\$3.52/resident per year (s.e. = 11.71), falling because of the estimated annual decline in the city's property tax base.[33] Annual growth in tax bases is estimated to add at most 1.5% (for New York City) to aggregate city revenues.

If our sample cities are to receive any revenue relief, it will have to come from favorable, and generally large, shocks to each city's key economic sector.[34] For example, a

[33] Calculations based on the estimated constant term for the IV estimates reported in Table 4. Estimates and calculations available upon request.

[34] All calculations here are based upon the IV estimates of each tax base equation, with each city's economic shock variable included. For Houston the estimated coefficient for ΔFUEL equals 732.0 (s.e. = 283.3) in the property base equation. For Minneapolis, the estimated coefficient for STADIUM equals 869.7 (s.e. = 566.6) in the property base equation. For New

one standard deviation increase in crude oil prices from the mean of \$15.20/barrel to \$23.07/barrel (ΔFUEL = \$7.87/barrel) adds \$5760/resident to Houston's property tax base (= ΔFUEL $\cdot$ ∂BASE/∂FUEL = \$7.87 $\cdot$ 732 (IV estimates)) and \$127/resident to Houston revenues using the city's revenue-maximizing tax rate (= .022 $\cdot$ \$5760). For Houston, favorable oil shocks are an important source of new city monies, here providing the city with an additional 14% in property tax revenues (= \$127/\$917). Of course, a one standard deviation decline in oil prices will have an equally large but negative impact on Houston revenues. As noted earlier Minneapolis's tax base benefited significantly from the seven years of state-funded downtown construction (STADIUM), adding \$10,892/resident to the city's property tax base and potentially \$547/resident to city revenues evaluated at the maximal rate of .0503. Another construction boom of this magnitude seems unlikely, however. The recent run-up in the DOW has helped New York City revenues, particularly income tax revenues. Our estimates suggest a one standard deviation increase in the DOW of 1142 points will translate into an increase in New York City's income tax base of \$845/resident (= ΔDOW $\cdot$ ∂IncomeBASE/∂DOW = 1142 $\cdot$ .74 (IV estimates)) for an annual 10 percent increase in city income tax revenues of \$49/resident per year when evaluated at the city's income tax revenue-maximizing rate (= .0579 $\cdot$ \$845). Finally, Philadelphia revenues benefit from increases in national health care expenditures. A one standard deviation increase in national health spending of \$750/person is estimated to increase Philadelphia's property tax base (the only significant effect) by \$4470/resident (=

York City, the estimated coefficient for ΔDOW equals -.23 (s.e. = 1.04) in the property base equation, -.05 (s.e. = .16) in the sales base equation, and .74 (s.e. = .56) in the income base equation. For Philadelphia, the estimated coefficient for ΔHEALTH equals 5.96 (s.e. = 3.76) in the property base equation, -.14 (s.e. = 4.20) in the gross receipts base equation, and -.76 (s.e. = 1.20) in the wage base equation.

ΔHEALTH $\cdot\, \partial$PropertyBASE/∂HEALTH = \$750 $\cdot$ 5.96 (IV estimates)) and the city's property tax revenues by \$137/resident evaluated at the estimated maximal rate (= .0306 $\cdot$ 4470), a 28% jump in property tax revenues.

Fourth, no city should be at the top of its longer-run revenue hill where the marginal revenue from a small rate increase, and thus marginal public service benefits, are zero. Yet all four of our cities are at, near, or even over the top, of their respective revenue hills. Philadelphia wage taxation is the only exception. Why? Two answers suggest themselves. First, when the dynamic structure of the local economy leads to a divergence of the short-run and longer-run revenue hills, politicians seeking re-election in the short-run may not be able to credibly promise to hold rates at a preferred longer-run allocation; see Inman (1989). In our sample, however, the impact and longer-run revenue hills diverge only for Minneapolis (property) and Philadelphia (property), and even in these cities the longer-run effects are fully felt within three to four years. Current voters are likely to bear, and therefore unlikely to ignore, the negative effects on home values of short-term property tax rate increases. A second explanation seems more promising -- it may be simply that our cities' decisive voters want high tax rates and a lot of public services. If so, evidence from our property tax base equations (Table 1) suggest this decisive voter is not a value-maximizing homeowner. In our cities, purchasers of city property place a negative net benefit on each marginal dollar of public spending paid for through a dollar increase in property taxation; see Section III.B above. If homeowners are not the decisive voters, who are? At least in Philadelphia, public employee unions and residents of lower income neighborhoods are two likely candidates (Inman, 1995). These two groups proved decisive in the recent mayoral victory of Democrat John Street, the previous president of City Council who ran on a neighborhood spending platform. His opponent, Republican Sam Katz made as his central campaign promises the expanded contracting-out of government services and the reduction in the city's wage tax rate from 4.6 to 4.0 percent. Street defeated Katz 51%-49% largely because of the strong voter turnout and support from the city's unions and lower-income neighborhoods.[35] While local economics determines a city's revenue hill, local politics determines where on that hill the city resides.

V. Conclusions

Understanding the equilibrium effects of local taxation on the local private economy is important for elected city leaders, urban policy-makers, and academic economists alike. Our analysis provides some important lessons for each group.

First, the mayors of each of our sample cities are revenue constrained. Current tax rates in Houston, Minneapolis, New York, and Philadelphia place each city very near the top of each of its longer-run revenue hill(s). The Philadelphia wage tax is the one exception, but raising city wage tax rates will cost the city jobs and residents. There is no obvious relief in sight. None of our cities' tax bases show significant long-run growth. Favorable economic shocks have been identified for each of our cities -- oil prices for Houston, downtown construction for

[35] For a summary of the election see, the *Philadelphia Inquirer*, November 3, 1999. Mayor Street is now in office, and union contracts come due this summer. A recent article in the *Philadelphia Inquirer* on the coming labor negotiations quotes the Mayor's inaugural address as saying: "We're going to work together. We're going to try to be fair in our relationships with the unions and the great workforce of the city, and give them a quality of benefits that they are entitled and that we can afford." In addition, the Mayor's address promises $250 million for clean-up and physical improvements for the city's poorer neighbhorhoods. See the *Philadelphia Inquirer*, January 25, 2000, p. R-1.

Minneapolis, a rising Dow for New York, and expanding health care spending for Philadelphia -- but large upswings are needed for there to be any important revenue relief. Controlling local expenditures seems essential for avoiding future fiscal crises.

Second, for New York City and Philadelphia, the two cities for which annual employment data are available, we find city income and wage tax rates have important effects on the location of jobs within the city. In New York City, a 10 percent increase in the city's resident income tax leads to a 2.2 percent loss in total jobs and a 4.0 percent loss in manufacturing jobs. In Philadelphia, the city's resident and non-resident wage tax has even stronger negative effects. Here a 10 percent increase in the weighted average wage tax rate leads to a 5.4 percent decline in total jobs and an 7.8 percent loss in manufacturing jobs. Reducing these taxes will restore job opportunities to immobile, most likely poor, city residents but at a likely cost of fewer city services. The estimated present value costs in lost revenues of each city job created by a tax cut are $80,167/job in New York City and $90,229/job in Philadelphia.

Third, when statistically significant, our longer-run elasticities of base with respect to rates, $-.39 \geq \varepsilon^{LR}_{B,\tau} \geq -1.27$, generally exceed in absolute value the current estimates of the elasticity of the U.S. federal personal income tax base with respect to rates ($\approx -.43$, Gruber and Saez, 1999) but are strikingly close to the elasticities obtained by Hines and Rice (1994) of -1.0 for small countries operating as international tax havens. Further, our estimated impact and longer-run elasticities provide useful benchmarks for specifying Rosen-Roback style structural models of fiscal policy in small open economies. The estimated impact effects on city property values of changes in wage and income tax rates in New York and Philadelphia and in neighboring Connecticut and New Jersey are best understood using Figure 1 and a $V_0(\cdot)$ schedule which is rises steeply and a $\Pi_0(\cdot)$ schedule which falls modestly. $V_0(\cdot)$ will be steep when city households strongly value other goods more than living space, while $\Pi_0(\cdot)$ will be weakly downward sloping when space, including vertical space, plays a relatively important role in firm production.

Fourth, estimates of the city revenue hills provide the fiscal constraint necessary to econometrically identify preferences of elected city officials. Our cities have all chosen to push revenues to the top of their respective revenue hills. Why? The most likely explanation is a political economy model which assigns a decisive role to voters with very high demands for public dollars. The fact that property values fall as property rates increase suggest that in our cities at least, these decisive voters are not value-maximizing homeowners.

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Appendix A: Data Appendix†

Base, Rates, and Economic Environment

Property Tax	Houston (1969–1997)	Minneapolis (1973–1997)	New York (1962–1997)	Philadelphia (1971–1998)
Base_p	\$45,867 (8,757)	\$30,147 (5,027)	\$27,723 (7,838)	\$16,275 (3,133)
ΔBase_p	\$218.3 (3,809.3)	\$333.0 (1,285.4)	\$291.2 (2,941.1)	\$181.0 (987.5)
τ_p (%)	1.70 (.42)	3.19 (.54)	3.61 (.68)	2.77 (.34)
$\Delta\tau_p$ (%)	.04 (.12)	.02 (.27)	−.01 (.22)	−.02 (.23)
Rate Changes (+/−)	10/17	16/8	11/21	9/18
Sales/Gross Receipts Tax			(1961–1997)	(1968–1998)
$\text{Base}_{s,X}$	—	—	\$8,213.69 (963.58)	\$17,707.1 (3,028.6)
$\Delta\text{Base}_{s,X}$	—	—	\$9.43 (630.81)	\$244.2 (1,568.2)
$\tau_{s,X}$ (%)	—	—	3.55 (.64)	.35 (.05)
$\Delta\tau_{s,X}$ (%)	—	—	.05 (.32)	−.00 (.04)
Rate Changes (+/−)	—	—	3/1	3/6
Income/Wage Tax			(1971–1996)	(1969–1998)
$\text{Base}_{w,w+m}$	—	—	\$10,420 (2,758.3)	\$13,431 (944.0)
$\Delta\text{Base}_{w,w+m}$	—	—	\$136.3 (1,472.9)	\$100.6 (376.0)
$\tau_{w,w+m}$ (%)	—	—	4.10 (.40)	4.32 (.59)
$\Delta\tau_{w,w+m}$ (%)	—	—	.09 (.39)	.06 (.21)
Rate Changes (+/−)	—	—	5/4	3/3
Jobs			(1972–1996)	(1971–1998)
$N + M$	—	—	3,970,375 (152,632)	762,835 (61.131)
$\Delta N + \Delta M$	—	—	−13,216 (66,235)	−8,786 (12,680)

(continued)

Appendix A: Data Appendix (continued)

Economic Variables	Houston (1969–1997)	Minneapolis (1973–1997)	New York (1961–1997)	Philadelphia (1969–1998)
UE (%)	6.34	6.76	6.11	6.36
	(1.28)	(1.29)	(1.49)	(1.47)
ΔUE (%)	.05	−.00	−.02	.04
	(1.07)	(1.08)	(.98)	(1.02)
Z	\$258.3	\$937.5	\$1,864.0	\$821.8
	(92.6)	(93.5)	(369.3)	(156.0)
ΔZ	\$3.40	−\$3.72	\$48.86	\$29.90
	(29.2)	(116.8)	(188.7)	(80.83)
c	\$1.16	\$1.16	\$1.21	\$1.17
	(.11)	(.12)	(.14)	(.12)
Δc	−\$.01	−\$.01	−\$.01	−\$.01
	(.03)	(.03)	(.04)	(.03)
r (%)	3.54	4.01	3.49	3.49
	(3.29)	(3.52)	(2.95)	(2.95)
Δr (%)	.08	.16	.06	.06
	(2.46)	(2.27)	(1.93)	(1.93)
m	\$7.86	\$7.82	\$7.84	\$7.86
	(.36)	(.36)	(.34)	(.36)
Δm	−\$.01	−\$.04	\$.002	−\$.02
	(.12)	(.10)	(.12)	(.12)
CRIME	535.6	595.5	546.0	573.1
	(141.9)	(101.2)	(138.8)	(115.9)
ΔCRIME	17.07	8.08	11.93	10.07
	(28.29)	(33.34)	(31.28)	(31.52)
FUEL	15.20	—	—	—
	(7.87)			
ΔFUEL	.53	—	—	—
	(2.37)			
HEALTH	—	—	—	2,139.4
				(749.9)
ΔHEALTH	—	—	—	75.86
				(50.48)
DOW	—	—	3,141.5	—
			(1,142.7)	
ΔDOW	—	—	103.1	—
			(450.4)	

†Means and standard deviations (within parentheses) are reported. All dollar variables are in 1994 dollars. The (+/−) report the number of tax rate increases (+) and decreases (−) over each city's sample period. The variables UE (%), c, r, m, CRIME, FUEL, HEALTH, and DOW are national values with means and standard deviations calculated for each city's sample period.

Appendix B: First Stage Estimates for Local Tax Rates

Table B summarizes the first stage estimates of city tax rates for each of our sample cities. The Table provides the coefficient estimates for the excluded, predetermined variables for each city. Also included in each equation as exogenous regressors (but not reported in Table B) are a constant term, a time trend variable and the time trend squared, the national rate of unemployment lagged one period, and each city's federal and state aid less welfare spending lagged one period. The excluded pre-determined variables are meant to capture exogenous determinants of local tax rates operating either through the local political process or through state regulations of local government finances.

Local political variables include an election cycle indicator variable (*Elect*) equal to 1 for the two years before a mayoral election and 0 otherwise (when Houston had a two year mayoral term, Elect equaled 1 for the one year before the election), an indicator variable for Mayor Dinkins (*Dinkins*, New York only) who ran on a progressive tax platform, and the percent of the Philadelphia City Council who are racial minorities (*%MinCC*, Philadelphia only) to represent the significant shift in Council composition following the 1979 Abscam scandal. Variables meant to capture the influence of the state regulatory environment on local finances include the percent of state income collected as states taxes other than state income taxation lagged one period ($\tau_{state}(-1)$), the percent of general state and local spending done directly by the state (*%SLExpS*), the percent of the state lower chamber who are Democrats (*%LegDem*), an indicator variable equal to 1 if the state's Governor is a Democrat (*GovDem*), and, for Houston only, future annexation measured by city land area with a one year lead (*Land*(+1)), for New

York City only, the level of MAC bonds outstanding lagged one period (*MACDebt*(-1)), and for Philadelphia only, an indicator variable for the 1977 borrowing crisis in which Wall Street required tax rate increases to balance a deficit budget (*Crisis77*) and the 1985 state-mandated reform of the city's business taxes requiring a reduction in the city's gross receipts tax rate (*85BTxRef*). When statistically significant or nearly so, each variable influenced local tax rates in the expected direction: *Elect* (-), *Dinkins* (- in τ_p, + in τ_w), *%MinCC* (-), τ_{state} (-), *Land* (-), *MACDebt* (+), *Crisis77* (+), and *85BTxRef* (- in τ_X, + or 0 for τ_p and τ_{w+m}). We are agnostic as to the likely effects of *%LegDem* and *GovDem* on city tax rates, holding constant state to city aid (as our specification does). On the one hand, democratic state governments are likely to increase local government mandates, particularly for services for the poor (+ coefficient as in Minneapolis and New York City), but on the other hand, democratic states may wish to favor democratic city administrations in ways not measured by grants-in-aid (e.g., providing more state services within city boundaries, - coefficient as in Philadelphia). When significant, *%SLExp* had a positive effect on Houston, Minneapolis, and New York property taxation, implying cooperative, not competitive, fiscal federalism.

As a group the excluded predetermined variables are significant explanatory variables for city tax rates. Though we cannot reject non-stationarity for the level series of tax rates and the continuous value instruments in Table B, individually the variables are stationary in first differences. Under the hypothesis that the system is I(1), the Durbin-Watson test statistic for the null hypothesis of non-stationarity of the residuals from the co-integrating regression is appropriate (Engle and Granger, 1987). For each tax rate regression in Table B, the Durbin-Watson test statistic allows us to reject the null hypothesis of non-stationarity, or of no co-integration, at the 1 percent level of significance (D.W. $\geq$ .511; Engle and Granger, 1987). For completeness, the Augmented Dickey-Fuller test statistics for the stationarity of the error terms of the co-intergrating regression assuming higher-order autoregressive processes are also reported (MacKinnon, 1991). Our tax rate regressions pass this more demanding test in four of our eight specifications. Assuming a stable, co-integrating regression, the predicted tax rates using the level regressions from Table B are then used to compute predicted first differences in rates for IV estimation reported in Table 4.

The quality of the predictive equation will determine the degree to which our instruments successfully control for simultaneous equation bias. As recommended by Bound, Jaeger, and Baker (1995) and Staiger and Stock (1997) we report the partial R^2 and the F statistics for the first-stage estimates. The partial R^2's measuring the variation in local tax rates explained by the instruments alone all exceed .32, and all but Minneapolis are .50 or larger. P-values based upon an F test for the statistical significance for each group of excluded predetermined variables uniformly rejects the null hypothesis of no influence of the selected instruments; see Table B. For less than perfect instruments (i.e., instruments potentially correlated with the error terms of the tax base equations), the inverse of the reported F statistic (1/F) is an approximate measure of the finite sample bias of our IV estimates of the effects of rate on base relative to the OLS estimates of the same coefficients; see Bound, Jaeger, and Baker (1995) and Staiger and Stock (1997). Thus IV estimates based upon first stage equations with values of $F \simeq 4$ will correct approximately 75% of any simultaneous equation bias. By this criterion, our IV estimates for Minneapolis property taxation in Table 4 and for Philadelphia wage taxation in Tables 4 and 5 should be interpreted with care.

Appendix Table B: IV First Stage Estimate for Local Tax Rates†

Excluded Predetermined	Houston	Minneapolis	New York			Philadelphia		
	τ_p	τ_p	τ_p	τ_s	τ_w	τ_p	τ_X	τ_{w+m}
Elect	.016	.075	−.104	.072	.024	−.026	−.012	−.001
	(.031)	(.125)	(.057)	(.075)	(.076)	(.051)	(.009)	(.070)
$\tau_{\text{state}}(-1)$	.084	.268	.150	.090	−.433	−.425*	−.024	.144
	(.086)	(.328)	(.211)	(.267)	(.286)	(.207)	(.037)	(.271)
% SLExpS	3.673*	10.317	5.118	−2.663	−1.711	−.203	−.540	1.952
	(1.456)	(8.802)	(3.601)	(5.224)	(5.115)	(1.818)	(.343)	(2.486)
% LegDem	−.165	2.633	3.358	5.659*	.462	−1.821	−.204	−3.553
	(.807)	(1.414)	(2.044)	(1.115)	(2.103)	(1.326)	(.251)	(1.822)
GovDem	.023	−.103	−.340	−.119	−.189	−.158	−.037*	.048
	(.045)	(.204)	(.233)	(.197)	(.253)	(.095)	(.017)	(.126)
Land(+1)	−.005*	—	—	—	—	—	—	—
	(.002)							
MACDebt(−1)	—	—	.0003*	.0004*	.0004*	—	—	—
			(.0001)	(.0001)	(.0001)			
Dinkins	—	—	−.379*	−.098	.484*	—	—	—
			(.098)	(.148)	(.110)			
Crisis77	—	—	—	—	—	.671*	.093*	.669*
						(.176)	(.032)	(.232)
% MinCC	—	—	—	—	—	−.466	−.300	−.300
						(.876)	(.164)	(1.189)
85BTxRef	—	—	—	—	—	.062	−.094*	.261
						(.124)	(.023)	(.171)
$\bar{R}^2$	.97	.70	.96	.80	.88	.85	.79	.95
$\bar{R}^2$(partial)	.94	.32	.69	.78	.65	.76	.50	.83
F	3.66	2.61	6.79	5.73	5.78	3.85	4.92	2.15
(p-value)	(.018)	(.072)	(.001)	(.001)	(.001)	(.011)	(.003)	(.088)
D.W.	1.66	1.27	2.21	2.17	2.23	2.54	2.04	1.68
ADF	−3.50	−3.16	−6.22*	−7.05*	−5.85*	−4.42	−5.96*	−4.19

Appendix Table B Notes

†Standard errors for each estimated coefficient are reported within parentheses. In addition to the excluded predetermined (instrumental) variables listed above, each local tax rate equation also includes as exogenous variables a constant term, Time, Time^2, $UE(-1)$, and $Z(-1)$. The reported test statistics include: $\bar{R}^2$, $\bar{R}^2$(partial) as the coefficient of determination corrected for degrees of freedom for the excluded predetermined variables only; F as the F test statistic for the null hypothesis that the excluded predetermined variables jointly have no influence on the local tax rate; p-value for the associated F statistics; D.W. as the Durbin-Watson test statistic for serial correlation of the equation errors, and ADF as the augmented Dickey-Fuller test statistic for stationarity of the error terms of the OLS regression.

*Coefficient's t statistic ≥ 2.00. ADF test statistic rejecting non-stationarity at the .10 level of significance or better (ADF ≤ -5.20).