Federal Reserve Bank of New York
Staff Reports

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Staff Report no. 186
May 2004

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JEL classification: H7, R3

Abstract

In this paper, we study the question whether suburbs should help finance the core public services of their central cities. We review three arguments that have been offered in favor of suburbs' fiscal assistance to their central cities. First, the central city provides public services that benefit suburban residents. Second, the central city may provide redistributive services to low-income central city residents that benefit suburbanites with redistributive preferences for such transfers. For efficiency, suburbanites should contribute toward such services in proportion to the benefits they enjoy. Third, the central city's private economy may be an efficient production center because of agglomeration economies, that is, increasing returns, in the production of goods and services consumed by suburban residents. Distributive city finances—for example, rent-seeking—may undermine those economies by driving businesses or residents from the city. Suburbanites may wish to contribute toward the costs of such fiscal redistribution if those contributions reduce the number of firms and residents leaving. We examine the effects of suburban transfers in a structural model of a metropolitan economy that is consistent with the last of these explanations and with the city-suburban interdependence literature.

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It is by now widely accepted that city and suburban economies move together over time, and that the connection is not simply the result of the fact that shocks to the two parts of metropolitan area economy tend to be correlated. Instead, it appears that negative shocks that are specific to the city also result in reduced well-being in the suburbs (Haughwout and Inman 2002).

What, if anything, this fact implies for metropolitan fiscal institutions and policies is less clear, in part because the structural sources of the correlations remain somewhat obscure. In this paper, we study a structural metropolitan fiscal model that is capable of replicating the correlations between city and suburban outcomes that have been observed by many authors (Voith 1993, 1998; Brooks and Summers no date, Haughwout and Inman 2002). Two important features of the model generate city-suburban interdependence: non-reproducible agglomeration benefits in the city, and suburban production that relies in a fundamental way on the productivity of city firms. The question we address here is whether, and to what extent, these features support suburb to city fiscal transfers. That is, we ask whether such transfers offer the potential to enhance the well being of both city and suburban residents.

The paper is organized as follows: Section I reviews some empirical evidence supportive of the contention that city and suburban economies tend to move together and briefly discusses some potential structures that could generate these correlations. Taking what we believe to be the essential messages of these studies, we develop a model of metropolitan economies in section II. Section III presents simulation results for a series of suburb to city fiscal transfers and section IV concludes the paper.

I. City-Suburban interdependence

The notion that the central city has something of importance to suburbanites is hardly new; see, for example, Jackson's (1985, chapter 8) review of the arguments in favor of municipal consolidation in the 19th century. As municipal annexation slowed in the 20th century, some scholars began to argue that the well-known benefits of metropolitan decentralization promoted by Tiebout (1956) obscured some important arguments in favor of metropolitan governance or other forms of financial assistance from suburbs to cities. Among these arguments were three that became particularly relevant.

First, some authors argued that suburbanites "exploited" the city by benefiting from city-produced public goods without contributing to their construction and operation (Neenan 1970). Theoretically, this kind of direct public good benefit spillover could lead to underprovision of public goods in the city, as city residents equate their own marginal benefit with marginal cost, ignoring the positive externality. Regionalizing public finance could generate contributions for city public goods valued by residents of the suburbs. Yet the solution to this problem is not, in general, intergovernmental transfers: where feasible, user fees and average cost pricing, charged without regard to residential location, is the most efficient means of allocating such public goods.

A second argument sometimes put forward in favor of fiscal transfers in metropolitan areas is based on suburban altruism. If suburbanites value the welfare of the geographically proximate poor, then they might wish higher subsidies to these families than the city provides (Pauly 1973). Yet the primary responsibility for determining the level of transfers to the poor generally resides at the state level and the fact that in many states the median voter is a suburbanite. It is not clear that allowing suburbanites directly to choose (and help finance) the level of transfer income received by city poverty households would substantially change the outcomes we currently observe.

Recent research has returned to the theme, albeit from a perspective different from those which dominated the academic literature in the 1970s. Whereas the previous literature had emphasized equity and altruism as motivations for suburbanites to either consolidate with, or at a minimum make financial contributions to, their central cities, the recent literature has explored whether doing so may is in suburbanites' own self interest. The foundation of this argument is a series of recent papers documenting positive correlations between city and suburban economic outcomes.[1] Figure 1 and Table 1 provide some evidence of this relationship which, on its face, suggests that suburbanites may care about what happens in their central city because it has important implications for what happens to them.

While it difficult to uncover a structural relationship by examining simple correlations among outcome variables, the patterns in the table and figure provide some insight into the structure of the relationship between cities and their surrounding suburbs. In particular some features of the data rule out, or at least severely undermine, certain structural explanations. First, growth in both incomes and housing values are positively correlated for city-suburb pairs. Were the appeal of strongly growing central cities based on consumption opportunities or aid packages to the poor valued by suburban households, standard compensating variations logic (Rosen 1979) would imply that

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[1] See especially Voith (1993, 1998) and Brooks and Summers (no date) A more complete survey is available in Haughwout and Inman (2002).

incomes would fall in response to improving central city economic health. Instead the raw data suggest that that firm productivity is playing an important role in connecting cities and their suburbs (Haughwout 2002). If the connection between city and suburbs is on the production side, then we would anticipate that positive productivity shocks to the city would raise incomes in both city and suburbs.

Second, size matters: the income and house value correlations are strongest in large MSAs, which tend to be those with larger central cities.[2] This indicates that the scale at which city production takes place is important in determining how "connected" the city and its suburbs turn out to be. Urban economists have long studied productive agglomeration economies arising from city size or density. Recent work (Rosenthal and Strange 2001) indicates that the benefits of agglomeration decay rapidly over distance, implying that large central cities may offer distinct productivity advantages over suburbs and smaller central cities.

There are several channels by which stronger growth in a central city could lead to these growth patterns in its suburbs. One is commuting: higher firm productivity in the core of the metropolitan area could raise welfare throughout the area if some workers live outside the center. Voith (1993) shows that this linkage is a significant determinant of suburban housing prices. But we argue that there must be more to the story. The importance of suburb-to-city commuting has clearly diminished over time, while the linkages between city and suburb appears to have strengthened, particularly in house values, which we have argued elsewhere is the best indicator of fiscally induced changes in welfare (Haughwout and Inman 2002; Haughwout 2002b).

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[2] The role of city size increases when we examine structural or reduced form models. See Voith (1998) and Haughwout and Inman (2002) for more detail.

A second possible source of the positive correlation, and the one on which we will focus in the balance of this paper, arises from vertical production linkages. We specify a model in which the central city offers production advantages that are not readily reproducible in the suburbs. Suburban firms buy inputs from city firms and convert them to finished goods that they sell to suburban consumers. As we show below, this structure generates interdependence that is consistent with the data.

While intra-metropolitan trade is poorly measured, there exists modest empirical evidence in support of this structure. Rosenthal and Strange (2001) find evidence of input sharing of the sort we model below. Schwartz (1992), analyzing a survey of suburban employers, finds them to rely heavily on producer service providers in their own central city. Haughwout and Inman's (2002) reduced form analysis of the data for MSA growth between 1980 and 1990 find that indicators of the strength of agglomeration benefits in the core of metropolitan areas are statistically and economically significant determinants of growth in suburban incomes and house values.

We thus propose a structural model of metropolitan economies that incorporates two critical features: a central city agglomeration externality that gives it an advantage in production of basic goods and services, and a city-suburb linkage through trade. The model results in equilibrium configuration that is, because of these non-convexities, inefficient. The model thus bears similarities to the work of Helsley and Strange (1994, 1997) who show that limits on developers or constraints on the number of developers result in inefficient equilibrium configurations. The next section outlines the details of our model.

II. Model

Our model treats the metropolitan area as a small, open economy occupying a fixed land area, and facing perfectly elastic supplies of private capital and workers. The metropolitan land area is broken into two exogenously given parts: a central city and the suburbs. We treat each as an independent political jurisdiction housing producers, workers and dependent households. Both jurisdictions provide local public goods, and the city offers an agglomeration externality to producers located there; there is no agglomeration available in the suburbs.

Private economy

A. City

City firms buy capital (K), land (L_f), resident workers (N), and non-resident commuter managers (M) to produce a common consumption good (X) to be sold at constant world price P_X, normalized to 1. X may be consumed within the city, by city residents, or exported to the suburbs or the wider world market. All endogenous variables of the model are denoted in *italics*. The production technology for city firms is assumed to be constant returns to scale (linear homogeneous) over these four private market inputs. City firms also benefit from the endogenously provided all-purpose public good (G) and a positive externality from city employment density ($A=\sum(N+M)/L_0$), where L_0 is the exogenously determined land area of the city. Both G and A are assumed to influence firm production as beneficial Hicks-neutral shifters of the marginal productivities of 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 stock (= $1 \bullet K$). Firms use land within the city and pay the annual rental rate (R) plus the property tax (τ_p) on the value of that land (= $(R/r) \bullet L_f$). Our city production technology includes two kinds of labor: resident workers and commuter managers. While this specification conveniently describes labor's location in the United States, the model itself is sufficiently general to allow managers to live within the city and workers to be commuters, perhaps a more appropriate specification for European and South American cities. Firms hire resident labor (N) at the endogenously determined resident wage (W). Finally, firms hire non-resident managers (M) and pay these managers their competitive (exogenous) non-resident wage (S) inclusive of any compensation for city disamenities plus a compensating differential for commuter labor taxes imposed by the city at the rate τ_m. The gross-of-tax wage paid by city firms to commuter managers equals $(1+\tau_m) \bullet S$.

For production efficiency, city firms choose the cost minimizing input bundle defined by their common constant returns production technology needed to produce one unit of X, given taxes, public services and aggregate employment density in the city --

(1) $1 = X(k, n, m, \ell_f; G, A)$

where $k = K/X$, $n = N/X$, $m = M/X$, $\ell_f = L_f/X$, $A = \sum(N+M)/L$; the summation is over all employers in the city. Cost minimization is subject to an exogenous vector of local tax rates ($\boldsymbol{\tau_f} = \{\tau_p, \tau_m\}$), the endogenous level of the pure public good (G), and a constant average cost constraint inclusive of local tax payments:

c = $[r + \tau_p]\, k + W\, n + [1+ \tau_m]\, S\, m + [r+ \tau_p]\, (R/r)\, \ell_f$. The resulting firm demands for factor inputs, specified here as demand per unit output, are:

(2) $k = k(R, W;\ \tau_f, G, A; r, S)$;

(3) $n = n(R, W;\ \tau_f, G, A; r, S)$;

(4) $m = m(R, W;\ \tau_f, G, A; r, S)$; and

(5) $\ell_f = \ell_f(R, W;\ \tau_f, G, A; r, S)$.

In a free-mobility long-run equilibrium, firms cannot make excess profits or losses solely because of a 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 (2-5) above, the firms' zero excess profit constraint will be defined as average revenue ($1) minus per unit taxes (τ_X) minus average cost:[3]

(6) $1 - \tau_X - c(R, W;\ \tau_f, G, A; r, S) = \Pi_0(R, W;\ \tau_X,\ \tau_f, G, A; r, S, 1) = 0$.

Working residents living in the city consume three private goods -- an all-purpose consumption good (x_r), housing structures (h_r), and residential land (ℓ_r) -- and the all-purpose pure public good (G). Work effort by working residents is exogenous; there is

[3] 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. Given the assumptions of our model, the final burden of these local taxes will be shifted back onto land values.

no labor-leisure choice in our model. The residents are assumed to purchase the three private goods (x_r, h_r, ℓ_r). Consumption goods (x_r) are purchased at an exogenous world price (≡1) plus any local sales tax levied on consumption (τ_s).[4] Housing structures are constructed at the competitive price (≡1) and paid for through an annual rental cost sufficient to return a competitive rate of return (r). Households purchase land within the city at an endogenously determined annual rental price (R) and pay the local property tax (τ_p) levied on the value of land $(= (R/\mathrm{r})\cdot \ell_r)$ and structures $(= 1\cdot h_r)$. Total household expenditures on goods, housing, and land inclusive of tax payments may not exceed the annual resident wage (W) earned by working at city jobs, net of city wage taxes paid at rate τ_w: $[1+\tau_s]\, x_r + [\mathrm{r}+\tau_p]\, h_r + [\mathrm{r}+\tau_p]\,(R/\mathrm{r})\, \ell_r = [1-\tau_w]\, W$.[5] Residents maximize a common, well-behaved utility function $U(x_r, h_r, \ell_r; G)$ subject to this budget constraint, a vector of exogenous local resident tax rates ($\boldsymbol{\tau}_{\mathbf{r}} = \{\tau_s, \tau_p, \tau_w\}$), and the exogenous level of the local public good (G). The resulting resident demand curves for x_r, h_r, and ℓ_r are specified as:

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4 Requiring residents to consume x within the city removes the effect of local sales taxes on cross-border shopping; see, for example, Goolsbee (1999) for evidence. Alternatively, in our model residents are free to (costlessly) leave the city when the sales tax is increased.

5 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 both firms and workers, worker supply and demand are elastic; we assume that residents therefore bear the initial burden of the resident wage tax. These initial incidence assumptions do not affect the equilibrium incidence of local taxation, which is the focus of our analysis.

(7) $x_r = \mathrm{x_r}(R, W;\ \boldsymbol{\tau}_\mathbf{r}, G; \mathrm{r}, 1)$;

(8) $h_r = \mathrm{h_r}(R, W;\ \boldsymbol{\tau}_\mathbf{r}, G; \mathrm{r}, 1)$; and,

(9) $\ell_r = \ell_\mathrm{r}(R, W;\ \boldsymbol{\tau}_\mathbf{r}, G; \mathrm{r}, 1)$.

The long-run 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 the household's demands for x_r, h_r, and ℓ_r, the indirect utility function for a typical resident can be specified and set equal to the exogenous utility (V_0) available outside the city:

(10) $\mathrm{V}(R, W; \boldsymbol{\tau}_\mathbf{r}, G; \mathrm{r}, 1) = \mathrm{V}_0$.

Commuting managers consume private goods, housing, and land at suburban residential locations. We assume that commuters are able to buy private goods and housing at constant world prices. As noted, to attract these workers into city jobs requires city firms to pay a wage equal to the commuters' suburban wage inclusive of compensation for all (assumed exogenous) disamenities of working within the city -- e.g., the city's taxation of commuters' labor income. This compensating wage is equal to $(1+ \tau_m)$ S, where τ_m is the commuter wage tax rate.

The city is assumed to contain a fixed, immobile population of (D) poor and elderly *dependent households* who each receive an exogenous income transfer of Y dollars paid for by the central government and perhaps in part, through local taxation, by the city government as well. Dependent households consume the composite private good (x_d), housing (h_d), and land (ℓ_d) and pay taxes on their consumption. They do not pay taxes on their exogenous income transfer (Y). Dependent households also consume the pure public good (G) provided by the city government. We assume dependent households do not move from the city.[6] Dependent households maximize their household utility function, $U(x_d, h_d, \ell_d; G)$ subject to the vector of exogenous local resident tax rates ($\boldsymbol{\tau}_{\mathbf{d}} = \{\tau_s, \tau_p\}$), the exogenous level of the local public good (G), and a dependent household budget constraint: $[1+ \tau_s]\, x_d + [r+ \tau_p]\, h_d + [r+ \tau_p]\, (R/r)\, \ell_d = Y$. The resulting dependent resident demand curves for x_d, h_d, and ℓ_d are specified as:

(11) $\quad x_d = \mathrm{x_d}(R; \mathrm{Y}, \boldsymbol{\tau}_{\mathbf{d}}, G; \mathrm{r}, 1)$;

(12) $\quad h_d = \mathrm{h_d}(R; \mathrm{Y}, \boldsymbol{\tau}_{\mathbf{d}}, G; \mathrm{r}, 1)$; and,

(13) $\quad \ell_d = \ell_{\mathrm{d}}(R; \mathrm{Y}, \boldsymbol{\tau}_{\mathbf{d}}, G; \mathrm{r}, 1)$.

Given their demands for x_d, h_d, and ℓ_d, the indirect utility function for a typical dependent household can be specified as:

(14) $\quad \mathrm{V}(R; \mathrm{Y}, \boldsymbol{\tau}_{\mathbf{d}}, G; \mathrm{r}, 1) = V_d$.

Since dependent households cannot escape the city, their equilibrium level of utility (V_d) is endogenous.

B. Suburbs

Like the city, the suburbs host a single type of firm, and several different kinds of residents. *Suburban firms* provide retailing services to suburban residents using "unfinished" output (x_s) purchased from either the central city (x_s^c) or from producers outside the metropolitan area (x_s^o), where $x_s = x_s^c + x_s^o$. Purchased inputs are combined with resident suburban labor (n_s), capital (k_s), and land ($l_{f,s}$) using a nested Cobb

[6] For evidence that the average welfare household is not very sensitive to fiscal incentives in its location decisions, see Meyer (1999). Epple and Romer (1991) allow for mobile rich and poor households in their

Douglas-CES specification. Suburban retailing also benefits from suburban produced public infrastructure (G_s):

$$(15) \quad x_s = [.5x_{s}^{\rho} + .5(n_s^{.85}\ k_s^{.10}\ l_{f,s}^{.05})^{\rho}]^{1/\rho}\ G_s^{.04}$$

The parameter ρ defines the elasticity of substitution, ε=1/(1-ρ), between unfinished output and the labor-capital-land composite input. We set ρ = -999 (ε=.001) to reflect our assumption that the unfinished good is essential to suburban retailing. Suburban firms select inputs to minimize the costs of providing retailing services, where costs of retailing are defined as:

$$(16) \quad C_s = (r + \tau_{p,s})\ (R_s/r)\ l_{f,s} + W_s\ n_s + (r + \tau_{p,s})\ (k_s/r) + x_s^c\ (k^c + t^c) + x_s^o\ (k^o + t^o),$$

where we assign per unit costs $k^c = k^o \equiv 1$ as a normalization, per unit transportation costs from city to suburb as $t^c \equiv 0$ as a normalization and per unit transportation costs from outside the metropolitan area to the suburbs as $t^o = .15$. The value $t^o = .15$ was chosen to ensure suburban land values in the simulation model equal actual Philadelphia area suburban land values.

All suburban residents buy all their private good consumption from suburban "retailers" even though they might actually consume the good within the central city

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model of an open city in a metropolitan economy, but in their model all household incomes are exogenous.

(entertainment; hospital services; legal services).[7] City firms have a transportation cost advantage over non-MSA firms in meeting suburban residents' demand for the common consumption good. It is this proximity to low cost central city production which makes suburban locations attractive. In specifying our model, the transportation cost advantage for city firms is set at $.15/dollar of suburban imports, chosen to approximate actual Philadelphia suburban land values in our baseline simulations. It is possible that in equilibrium city firms may not be able to supply all suburban demand. In this case the consumption good is imported by suburban retailers from outside the MSA; transportation costs are necessarily higher for these marginal units.

All suburban households share city residents' common utility function defined over this single consumption good, housing structures, land, and the locally-produced public good. There are three types of households resident in the suburbs: mobile resident-worker households, who reside in the suburbs and work at suburban retailers at the endogenously determined suburban wage W_s, immobile dependent households, who receive the same exogenous transfer income Y as city dependent households, and city managers, who work in the city (see above) at $(1+ \tau_m)S$, but consume in the suburbs.

Equilibrium of the private urban economy

An equilibrium for the private sector of the urban economy requires that several conditions be met:

- Utility of city and suburban mobile resident-workers is the equilibrium level V_0

[7] City residents receive their retailing services directly from city firms as a by-product of city firm production.

- City and suburban firms earn zero economic profits
- Both the city and suburban land markets clear
- Both city and suburban labor markets clear

Our equilibrium concept envisions mobile firms and households submitting "bids" - local land and labor price combinations that would make them willing to locate in the city or suburbs - based on the net fiscal and agglomerative benefits available to them in each location. In this, we follow the literature on urban quality of life, pioneered by Rosen (1979) and Roback (1982) and summarized in Gyourko, Tracy and Kahn (1999).

For firms, the zero profit condition yields a downward-sloping iso-profit curve in the local price space, depicted as $\Pi(\cdot) = \Pi_0$ in Figure 2. The position of the Π_0 function is determined by local conditions τ_X, $\boldsymbol{\tau_f}$, *G*, and *A,* while its shape depends on the elasticity of substitution between land and labor in the production function. Our CES-Cobb Douglas specifications yield unitary substitution elasticities between land and all other goods for both city and suburban producers. Less elastic substitution possibilities in production would flatten the Π_0 curve. Household bids, conditional on the relevant local fiscal characteristics $\{\boldsymbol{\tau_r}, G\}$ are represented by the upward sloping function $V(\cdot) = V_0$ in Figure 2. Again, changes in fiscal policy will shift the curve, while changes in preferences will alter its shape.

The equilibrium local price vector $\{W^*, R^*\}$ is given by the intersection of the two curves - the land price/wage combination for which both firm and household equilibrium conditions are met.[8] Individual firms and households then take these equilibrium prices,

[8] Our specifications of technology and preferences are well-behaved in the sense that they yield monotonic functions in the price space, yielding unique and stable equilibria.

local fiscal policies and employment densities as given when solving (2)-(5) and (7)-(9) and the analogous suburban demands. Solution of the city firm's problem yields per-unit-output demands for resident labor, managers, land and private capital. City households choose consumption of the composite good, housing capital and land.

Recalling that we assume constant returns over the private inputs, aggregate demand for productive factors of the city and suburban economy may then be determined by multiplying per-unit demands by aggregate output. In the city, the latter is defined as $X_c^* = (L_0 - D\ \ell_d)/(\ \ell_f + \ell_r\ n)$ where L_0 is the exogenous land area of the city.[9] In the suburbs, the analogous condition is $X_s^* = (L_s - M^*\ \ell_m)/(\ \ell_{fs} + \ell_{rs}\ n_s)$.

Public sector

City and suburban governments produce the pure public good $G_{c,s}$ from pre-existing public infrastructure stocks ($G^0_{c,s}$) net of the costs of remaining principal and interest ($r^0_{c,s}$) plus additional infrastructure stock that can be purchased from the aggregate revenues made available from locally-generated tax revenues ($T_{c,s}$), aid from higher levels of government ($Z_{c,s}$), revenues earned from existing local public financial assets ($\Phi_{c,s}$) less payments to city and suburban dependent populations (whose population share is $\delta_{c,s}$):

(17) $G_{c,s} = [G^0_{c,s}\ (r - r^0_{c,s})]/(r + \sigma)c_g + [T_{c,s} + Z_{c,s} + \Phi_{c,s} - \psi Y \delta_{c,s}](N_{c,s} + D_{c,s} + M_s)/(r + \sigma)c_g$

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[9] This expression for aggregate output results form the equilibrium condition that the land market clear. $L_0 = \ell_f X^* + \ell_r N^* + D\ \ell$, where N^* is aggregate demand for resident labor ($= X^*\ n(\bullet)$).

where δ is the rate of depreciation of public infrastructure, and c_g is the production cost of local infrastructure, set equal to $c_g \equiv 1$ for the simulations.

Local tax revenues ($T_{c,s}$) are endogenous, and are given by for $i = p, w, m, X,$ and s, and where B_i is the base of tax i, determined by the private market equilibrium defined above. In both the city and suburbs the only locally chosen tax rate is the local property tax. City property tax rates are chosen so as to maximize aggregate revenues, while the suburban median voter chooses the utility-maximizing level of G_s and then sets property tax rates so as to produce that level of public spending. If the city also uses a wage, sales, or commuter tax then aggregate city revenues includes revenues from those taxes as well at pre-determined rates.[10]

Solution Procedure

Through the government budget constraint, $G_{c,s}$ is a function of local wages and rents, household consumption, and firm production, while wages and rents, household consumption, and firm production depend in turn on $G_{c,s}$. The model is solved by first specifying arbitrary initial values for aggregate city employment density and local property tax rates $\tau_{p,c}$ and $\tau_{p,s}$ and public services $G_{c,s.}$ in the city and suburbs. We then calculate the private economic outcomes and tax bases and local revenues, resulting in new values for A_c and $G_{c,s}$. Still holding the initial property rate fixed, these new values imply new private market outcomes and thus new employment density, tax bases,

[10] In most US cities, the property tax is the primary tax under local control. Other tax rates are often strictly controlled by the state government.

revenues, and another set of new values for $G_{c,s.}$ We continue to solve the model iteratively until convergence is achieved for $G_{c,s}$. Our convergence criterion requires the levels of $G_{c,s}$ to be within \$1 of their previous iteration's values. Convergence occurs typically within 20 or fewer iterations. This is the public sector and private market equilibrium for the initial values of $\tau_{p,c}$ and $\tau_{p,s.}$ The political equilibrium then selects the value of $\tau_{p,c}$ which maximizes central city revenues and that value of $\tau_{p,s}$ which maximizes the median suburban income resident's welfare, iterating as above to calculate the equilibrium values of $G_{c,s}$ and the private economy for each property tax rate.

When simulating the effects of suburban subsidies to the city, we add several steps to this procedure. First, we calculate the baseline cost of the subsidy. We then re-solve for the city equilibrium, including the benefits of the subsidy. Finally, we calculate the new suburban equilibrium, conditional on both the cost of the subsidy (modeled as negative aid to the suburbs) and the potential benefit of a "larger" central city economy.

Calibration to Philadelphia MSA, 1990

Land available for firm and household locations is set to equal useable land area in Philadelphia and its suburbs. The city and suburbs are assigned exogenous poor and elderly populations equal to their 1990 census values of 112,000 poverty households and 65,000 elderly households for Philadelphia (CPOV = .20; COLD = .12) and 99,000 poor households and 282,000 elderly households for the surrounding suburbs (SPOV = .048; percent non-poor elderly = .13). Poor and elderly households are assumed to receive a transfer income of \$13,500/household from the state and federal governments and an additional \$1,340/household from their local government as the value of state and federal mandated services on their city and suburban governments (Summers and Jakubowski,1997). Philadelphia receives $3,753/household in intergovernmental transfers while the suburban government(s) are paid $3,777/household in transfers (1992 U.S. Census of Governments). Both Philadelphia and its surrounding counties have inherited stocks of the public good acquired from past investments but not yet fully depreciated. We have estimated the replacement value of these stocks for Philadelphia and its suburbs at $33,840/household in the city and $6,221/household in the suburbs; see Haughwout and Inman (1996). There is an annual cost to maintaining this stock equal to its rate of depreciation of .03 plus the residual interest and principal expenses due on the stock's initial debt. These costs of the inherited stock are paid before additions to the stock are purchased at a current interest rate of .04. In all equilibrium outcomes studied here, the final purchase of the public good by the city and the suburbs exceeds these initial stocks. Philadelphia has four taxes: a property tax, a resident wage tax, a non-resident (commuter) tax, and a tax on gross receipts on city firms. The suburban government can use a property tax or a resident wage tax. To make our simulations for the Philadelphia MSA as representative as possible, we restrict the city to use only the property tax to pay for the added costs of public services, and similarly, we require the suburbs to use the property tax to buy their additional units of the public good. City tax rates other than the property tax rate are exogenous and set at their FY 1990 values.

III. Simulating fiscal distributions in a metropolitan area

The solution to the model under the baseline parameters is shown in Table 2. Note that the starting point for our analysis is the equilibrium defined by the property tax rate that maximize city revenues, and that which maximizes the median (resident-worker) household's welfare. Since Philadelphia' actual 1990 property tax rate was somewhat below the revenue-maximizing rate (2.9%), the city and suburban equilibrium values reported in Table 2 are smaller than the actual data for that year. Haughwout and Inman (2001) report detailed comparisons of the model's results with actual city outcomes.

The model is relatively successful at replicating results from Haughwout and Inman's (2002) empirical work. In Table 3, we report the results of these tests, in which the model for Philadelphia was used to simulate the effects of changes in city fiscal institutions on the city and suburban economies. These simulations, and their implication that suburban residents have a strong interest in the state of the business climate in the central city, serve as the basis for the analysis that follows.

Here, we offer simulations of a variety of potential suburban aid packages to the City of Philadelphia. Since the model is calibrated to a particular set of values, we confine the analysis to modest changes around the baseline described in Table 2. We describe four sets of simulations involving suburban subsidies designed to:

- Relieve the fiscal burden of city poverty
- Provide general purpose aid to the city government
- Reduce the burden of capital taxes on city firms
- Reduce the burden of capital taxes on city households

In the baseline, Philadelphia pays 9.5% of the annual cost of transfers to city dependent households. This cost raises city tax prices of both firms and households, reducing the equilibrium size of the city (Haughwout and Inman 2001). In 1990, this mandate cost the city $182 million per year (million). We simulate the effect of three levels of suburban subsidy for this burden, with the suburbs funding 50%, 75% and 100% of its cost. Provision of this subsidy to the city reduces public good availability in the suburbs, taxes constant, by between $1.8 (=$91M/0.05) and $3.6 billion (=$182M/0.05). This reduction in suburban public goods induces an initial decline in suburban land values of about $900 per acre for the case in which suburbanites shoulder 100% of the city's share of the transfer payment. But provision of the subsidy allows the city to provide additional public infrastructure, increasing its steady state employment, output and population. This increase in city size provides benefits to suburbanites by increasing the availability of the city-produced export good *X*. These benefits, like the cost of reduced suburban public good availability, are capitalized into suburban land values. The final results, displayed in the first panel of Table 4, indicate that this policy change would result in *net* benefits for suburban residents (measured as changes in the aggregate value of suburban land) ranging from $156 to $908 million, or between $150 and $900 per acre.[11] These land value changes represent about one to five percent increases over the baseline value of suburban land.

In our model, aid from other governments is an important source of funding for city and suburban public good provision. Another policy option for suburban residents would thus be to offer general purpose aid to their central city. Essentially, this entails diverting aid from the suburban to the city's treasury. We simulate three sets of general suburb-city aid packages representing five, 10 and 20 percent increases over the 1990 level of aid received by the city. The cost of these transfers and their net effect on

[11] Matters are less promising when the suburbs directly subsidize dependent residents' incomes. In this case, city dependent households consume more land, reducing the space available for production and diminishing the size of the suburban "proximity dividend". Such transfers *reduce* equilibrium suburban land values, offering negative returns.

suburban land values are reported in the second panel of Table 4. The results are strikingly similar to those in the first panel; inspection of equation (17) indicates why this is so. Both policies allow city government substantial autonomy in how it spends the proceeds of the subsidy provided by suburban residents. Our assumptions about city political economy, that the city always moves to the top of its revenue hill, yield a flypaper effect. This means that general suburban subsidies to the city will result in increased spending (public good provision) by city government.

An alternative policy design would be for suburbanites to provide more precisely targeted subsidies to the city. The primary concern of suburban landowners in our model is the city's productive capacity, which affects suburban well-being through trade linkages. Suburban residents might thus choose a policy that directly targets city firms, rather than both households and firms, when designing a subsidy program.

In our baseline simulation, Philadelphia is assumed to tax 75% of the productive capital located in the city. This assumption reflects the fact that machinery and other mobile capital are not taxed under the Philadelphia system, but firm land and structures are. The third panel of Table 4 shows the suburban effects of extending this business property tax abatement to a larger share of the city's productive capital stock. Targeting aid to city firms produces benefits that are far more substantial than those yielded by more general forms of assistance. For similar costs, subsidies to city firms offer benefits that are orders of magnitude larger than those provided by general aid packages. Even a relatively modest aid package of $251 million per year ($283 per family in equilibrium) is simulated to double suburban land values. The source of these increases is, of course, enormous gains in the productive environment of the central city. The initial gains are reinforced by increases in public good availability and agglomeration economies. In equilibrium, city output doubles when suburbanites subsidize city capital formation in this way.

For purposes of comparison, and to lead the discussion back to the structure of the model, we return the taxation of productive capital to its baseline value, and simulate the effect of a similar subsidy to housing capital. In the baseline, housing capital is fully taxable, the final panel of Table 4 shows the results of allowing households to exempt 25% and 50% from the property tax. The example is instructive, if only about the model we have built. In these simulations, the city is better off: city land values rise 4% when households can exclude 50% of their housing capital from the city property tax. City population and employment rise by similar amounts. Yet suburban residents are made moderately *worse* off. The cost of the program to suburban residents is relatively high ($600 per family per year in the new equilibrium) but its structure does not promote those elements of the city economy that provide benefits to suburbanites. While reducing to 50% the share of *productive* capital subject to the city property tax results in a doubling of city output, doing the same for *residential* capital results in just a 3% increase to the same measure. This is simply not enough of a benefit to compensate potential residents for the lost suburban public services, and bids for suburban land decline.

IV. Conclusion

The results in Table 4 indicate that a plausible structural model can generate the kinds of city-suburban outcome correlations that have been observed in the Census data for metropolitan areas. They also lend credence to the view that some kinds of modest suburb-city fiscal redistributions could raise welfare in all parts of the metropolitan areas. Three of the four sets of simulations reported in Table 4, for example, result in net land value increases in the suburbs.

In addition, we find that suburban transfers that directly subsidize city productive capital accumulation (or, more precisely, reduce the distortion introduced by city capital taxation) are considerably more effective at raising suburban land values than policies that ultimately result in more city spending or attract more residential capital. Indeed, reducing the effective tax rate by on city productive capital is simulated to double suburban land values, with similar increases for suburban house values. These are large benefits indeed, and contrast sharply with the negative returns produced by reducing residential capital taxation.

This last point is particularly important in the politically fragmented governance of many US metropolitan areas. The model here conflates Philadelphia's more than 300 suburban neighbors into a single governmental unit. In the real world of metropolitan politics, the information and coordination required to successfully design and execute any kind of fiscal redistribution is potentially extremely costly. While excluded from the model studied here, these costs serve as a significant barrier to the implementation of policies such as those described here. In this context, the promise of one to five percent land price increases may be insufficient to overcome these costs. Yet the highest of the net returns we simulate are truly significant, and could conceivably dominate the fixed cost of institutional design and coordination that prevail in even the most complex metropolitan area.

These results are, of course, produced by a single model with a very specific structure. Future research might pursue the importance of this structure, and study whether alternative structures that are able to replicate the empirical correlations will also generate similar policy implications.

REFERENCES

Brooks, Nancy and Anita Summers (n.d.), “Does the Economic Health of America’s Largest Cities Affect the Economic Health of Their Suburbs?” mimeo., University of Vermont and the Wharton School, University of Pennsylvania.

Epple, Dennis and Thomas Romer, 1991, "Mobility and Redistribution," *Journal of Political Economy*, 99, 828-858.

Goolsbee, Austan, 1999, In a World without Borders: The Impact of Taxes on Internet Commerce," NBER WP 6823.

Gyourko, Joseph and Joseph Tracy, 1991, “The Structure of Local Public Finance and the Quality of Life,” *Journal of Political Economy*, 99 (August), 774-806.

Gyourko, Joseph, Joseph Tracy and Matthew Kahn, 1999, "Quality of Life and the Environment," *Handbook of Urban and Regional Economics*, edited by Paul Cheshire and Edwin Mills, Vol. 3, pp.1413-1451. New York: North Holland Press.

Haughwout, Andrew, 2002, "Public Infrastructure Investment, Growth and Welfare in Fixed Geographic Areas," *Journal of Public Economics*, 83, 405-428.

Haughwout, Andrew, 2002b, "Local Public Sector Efficiency with Mobile Households and Firms," working draft, Federal Reserve Bank of New York.

Haughwout, Andrew and Robert P. Inman, 2001, “Fiscal Policies in Open Cities with Firms and Households,” *Regional Science and Urban Economics*, 31 (April), 147-180.

Haughwout, Andrew and Robert P. Inman, 2002, "Should Suburbs Help their Central City?" forthcoming, *Brookings Wharton Papers on Urban Affairs*.

Helsley, R. and W. Strange, 1994. “City Formation with Commitment,” *Regional Science and Urban Economics* 24: 373-390.

Helsley, R. and W. Strange, 1997. “Limited Developers,” *Canadian Journal of Economics* 30: 329-348.

Jackson, Kenneth, 1985, *Crabgrass Frontier: A Historuy of Suburbanization in the United States*, New York: Vintage.

Meyer, Bruce, 1999, "Do the Poor Move to Receive Higher Welfare Benefits," mimeo, Northwestern University.

Neenan, William, 1970. Suburban-Central City Exploitation Thesis: One City's Tale," *National Tax Journal*, 23, 117-139

Pauly, Mark, 1973, “Income Redistribution as a Local Public Good,” *Journal of Public Economics*, 2 (February), 35-58.

Roback, Jennifer, 1982, "Wages, Rents and the Quality of Life," *Journal of Political Economy*, 90., 1257-1278.

Rosen, Sherwin, 1979, "Wage-Based Indexes and the Quality of Life," in Peter Mieszkowski and Mahlon Straszheim, eds, *Current Issues in Urban Economics,* Baltimore: Johns Hopkins.

Rosenthal, Stuart and William Strange, 2001, “The Determinants of Agglomeration,” *Journal of Urban Economics*, 50 (September), 191-229.

Summers, Anita and Lara Jakubowski, 1997, “The Fiscal Burden of Unreimbursed Poverty Expenditures,” *Greater Philadelphia Regional Review*, 10-12.

Tiebout, Charles, 1956, "A Pure Theory of Local Expenditure," *Journal of Political Economy*, 64, 416-424.

Voith, Richard, 1993, “Changing Capitalization of CBD-Oriented Transportation Systems: Evidence from Philadelphia: 1970-1988, *Journal of Urban Economics*, 33 (November), 361-376.

Voith, Richard, 1998, “Do Suburbs Need Cities?” *Journal of Regional Science*, 38 (August), 445-464.

Table 1: City and Suburban Correlations

Correlations Between Levels of City and Suburban:			
	Home Values	Populations	Incomes
1970	. 311**	.547**	.559**
1980	.554**	.544**	.345**
1990	.696**	.526**	.353**

Correlations Between Growth Rates of City and Suburban:			
	Home Values	Populations	Incomes
1970 to 1980	.712**	.493**	.678**
1980 to 1990	.849**	.420**	.600**

Source: Haughwout and Inman (2002)

"City" corresponds to the largest central city in each MSA, while "Suburban" corresponds to the balance of the MSA not in the central city. There are 252 MSA's in the full sample. Correlations denoted with an ** are significantly different from zero at the .99 level of confidence.

Table 2: Baseline Simulation - Top of Philadelphia's revenue hill

	City	*Suburbs*
Output (Billion)	$ 15.8	$ 28.3
Consumption (Billion)	$ 6.7	$ 28.3
Land value ($ per acre)	$ 423,317	$ 19,752
Wages	$ 33,120	$ 27,090
Commuter/Manager wage	$ 140,081	-
Population	946,913	1,652,498
Jobs	339,091	406,036
Resident	222,357	406,036
Commuter	116,734	-
Property tax rate	2.90%	1.55%

Table 3: Estimated and Simulated Effects of Weak City Finances Philadelphia, 1990

	Δ City house values*	**Δ Suburban house values***
Δ City Tax Price = .01		
Simulated	-420	-2,264
Estimated	-3,638	-2,468
	(974)	(873)
Δ City Percent Poverty = .03, Large MSAs		
Simulated	-2,269	-2,312
Estimated	-12,345	-6,696
	(2,460)	(2,212)
Strong City Union = 1		
Simulated	-5,700	-2,410
Estimated	-5,358	-4,047
	(1,739)	(1,563)
Weak City Governance = 1		
Simulated	-4,646	-2,375
Estimated	-1,948	-3,035
	(1,052)	(946)

* Simulated results are change in value of land per household, estimated results are change in average house prices. Standard errors appear below the estimates.

NOTES

Source: Haughwout and Inman (2002), Tables 6 and 7.

Δ City Tax Price, excluding poverty = .01: Approximated by raising Philadelphia's initial percent elderly from 22.2% to 26.8%, sufficient to raise the city's tax price from 0.40 to 0.41.

Δ City Percent Poverty = .03: Approximated by increasing Philadelphia's initial percent poor from 20% sufficient to ensure an equilibrium percent poor equal to 23%, and increasing the mandated local share of transfer income costs from 0.095 to 0.2.

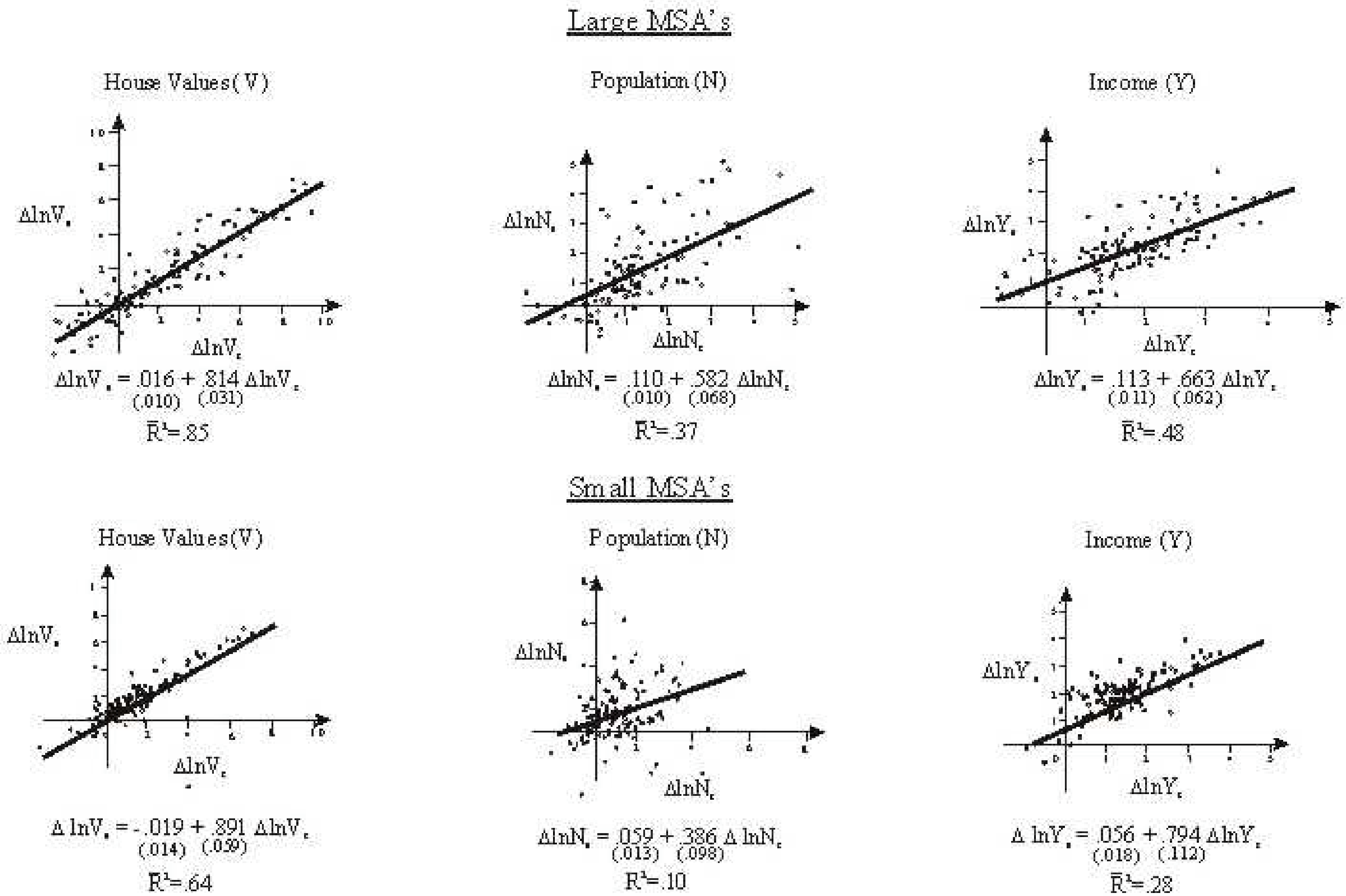
Strong City Unions = 1: Approximated by increasing the production cost of the public good for Philadelphia from 1 to 1.15 to approximate the relative growth in public employee wages in strong union cities during the 1980's.

Weak City Governance = 1: Approximated by increasing the share of the business property subject to the city's property tax from 75% to 85%, implying a balanced budget increase in public goods available for households and firms.

Table 4: Simulating Suburban Aid to the Central City
Philadelphia, 1990

	Aggregate annual cost ($ million)	Annual cost per household ($)	Δ Suburban Land value ($ per acre)	Δ Suburban House price ($)	Aggregate suburban benefit (net) ($ million)
1. Reducing city Ψ (Baseline value: 9.5%)					
To 4.75%	91.0	142.5	155.4	365.9	156.7
To 2.38%	136.4	213.1	290.2	664.1	292.5
To 0.0%	181.9	292.4	900.7	1,120.0	908.1
2. Increasing city Z (Baseline value: $2.1 billion per year)					
to $2.205 billion (5% addition)	103.6	161.3	448.3	539.4	452.0
to $2.31 billion (10% addition)	207.2	320.0	778.3	1,218.1	784.7
to $2.62 billion (20% addition)	414.4	628.9	1,534.4	2,581.7	1,556.1
3. Reducing business capital subject to city p-tax (Baseline value: 75%)					
to 50%	250.7	282.9	22,731.7	13,846.2	22,918.8
to 25%	501.5	351.2	167,781.2	33,915.4	169,161.9
4. Reducing residential capital subject to city p-tax (Baseline value: 100%)					
to 75%	187.3	297.0	-353.3	122.0	-356.2
to 50%	374.6	599.6	-748.1	252.7	-754.3

Figure 1: City-Suburban Growth Correlations



The panels illustrate the relationship between suburban and city home value appreciation, suburban and city population growth, and suburban and city income growth over the decade from 1980 to 1990, both for large and small MSA's. Large MSA's are defined as MSA's whose 1970 population was greater than or equal to 250,000; our sample includes 116 large MSA's. Small MSA's are defined as MSA's whose 1970 population was less than 250,000; our sample includes 128 small MSA's. Also reported are the OLS linear regressions relating city and suburban rates of population and income growth and city and suburban rates of home value appreciation.

Figure 2: Wage and Land Rent Equilibrium