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ABSTRACT

In the United States, workers in cities offering above-average wages – cities with high productivity, low quality-of-life, or inefficient housing sectors – pay 30 percent more in federal taxes than otherwise identical workers in cities offering below-average wages. According to simulation results, taxes lower long-run employment levels in high-wage areas by 17 percent and land and housing prices by 28 and 6 percent, causing locational inefficiencies costing 0.33 percent of income, or $40 billion in 2008. Employment is shifted from North to South and from urban to rural areas. Tax deductions index taxes partially to local cost-of-living, improving locational efficiency.

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1 Introduction

Wage and cost-of-living levels vary considerably across cities in the United States, yet the federal tax code does not take this variation into account. Since federal taxes are based on nominal incomes, workers with the same real income pay higher taxes in high-cost areas than in low-cost areas, without receiving additional benefits. Recognizing this, the Tax Foundation (Dubay 2006) argues:

> the nation is not only redistributing income from the prosperous to the poor, but from the middle-income residents of high-cost states to the middle-income residents of low-cost states.

While the Tax Foundation has suggested a flat tax to remedy this problem (Hoffman and Moody 2003), politicians from high-cost areas have proposed indexing federal taxes and benefits to local costs, arguing that workers with the same real incomes should pay the same nominal taxes.

For federal taxes to not distort the location choices of workers, the correct principle is that taxes should be independent of where workers live, so that location-wise they are effectively lump sum. The current system taxes workers more for taking jobs in a higher-paying cities, blunting the incentive to live in these cities, characterized by high firm-productivity and low quality of life. For example, in the New York metropolitan area, wage levels are 21 percent above the national average, which interacted with an effective marginal tax rate of 33 percent, creates a 7-percent federal surtax on labor income for locating there. Unlike local tax differences, federal tax differences of this kind are not compensated with higher levels of local spending, and may therefore affect location choices substantially.

Because federal taxes are not indexed to local wage levels, workers are induced to leave cities with high wages and move to cities with low wages. As a result, unindexed federal taxes lower employment levels and property values in high-wage cities, while having the opposite effect on low-wage cities. In equilibrium, these price changes compensate workers for federal tax differences across cities, but the resulting geographic distribution of employment is inefficient, reducing overall welfare.

The unequal distribution of federal taxes that results from wage differences across cities does not depend on the progressivity of taxes, and cannot be eliminated with a flat tax. The view that workers with the same real incomes should pay the same nominal taxes holds true across cities that vary in the productivity of their firms, as nominal incomes merely track cost-of-living differences across these cities. However, this view is incorrect across cities that vary in quality-of-life as nicer cities have a higher cost-of-living but lower nominal wage levels, and hence a lower federal tax burden. Indexing the tax code to local costs would eliminate federal tax differences across cities that vary in productivity, but exacerbate them across cities that vary in quality of life.

An empirical simulation for the United States below reveals that workers with the sameskills can pay up to 30 percent more in federal taxes in high-wage cities than in low-wage cities. The federal government effectively taxes workers for living in large cities, while subsidizing them to live in rural areas. Taxes also fall more heavily on the Northeast, Pacific, and Great Lakes regions and less on the South. Controlling for socioeconomic disparities, approximately 300 billion dollars each year are transferred horizontally from high-wage areas to low-wage areas. These findings partly confirm Senator Patrick Moynihan's claims in 24 years of reports, entitled *The Federal Budget and the States*, that the "federal balance of payments" across areas is highly unequal, although these reports do not control for socioeconomic differences across regions, nor do they consider the effects on local employment or prices.

Journalist Malcolm Gladwell (1996) writes that the inequality in the federal balance of payments "is according to urban experts and economists one of the best-kept secrets in American politics," and that "the decline of many northeastern American cities may be due not just to mismanagement — as is now popularly imagined — but to the emptying of their coffers by the federal government." Such a view is supported by the simulation: over the long run, federal taxes have lowered employment, housing prices, and land values in high-wage areas by 17, 6, and 28 percent, respectfully, and done the opposite in low-wage areas. Overall, federal taxes have tilted the geographic distribution of employment away from the North towards the South and away from urban areas towards rural areas, creating a welfare loss estimated at 0.33 percent of income, or $40 billion in 2008. Without federal tax deductions for mortgage interest and local taxes, this loss would be even larger.

Previous research about how federal taxes interact with local prices contains some important findings, but has been too narrow or informal to guide policy comprehensively. Wildasin (1980) finds that federal taxes on labor income cause mobile workers to locate inefficiently across cities offering different wages, but focuses on conditions characterizing efficiency, rather than the results of inefficiency. Without referring specifically to taxation, Glaeser (1997) argues that federal transfer levels should not be tied to local price levels, as this implicitly subsidizes recipients to live in expensive, high quality-of-life cities. More generally, Kaplow (1995) and Knoll and Griffith (2003) also allow productivity differences to affect local wages and prices, leading them to consider the benefits of indexing taxes to local wages. Although insightful, their informal arguments leave open the exact consequences of failing to index the tax code, raising the need for more rigorous quantitative analysis.[1]

Section 2 introduces a model of mobile workers who live in cities with attributes that generate differences in costs-of-living, wages, and federal tax burdens. Section 3 describes the federal tax differences that arise in equilibrium, and how this affects local prices. Section 4 examines how taxes distort location decisions and how to calculate the resulting efficiency loss. Then, section 5 considers the effect of indexing taxes to local wages or costs-of-living and demonstrates how tax deductions for locally-produced goods, such as housing, produce a mild and slightly altered form of cost indexation. Section 6 calibrates the model and simulates how differential taxes affect the distribution of local prices, employment, and welfare, taking into account differential federal spending patterns. Section 7 considers the effect of possible tax reforms, such as cost indexation of

[1] Kaplow's (1995) analysis holds prices fixed and presents an index formula that does not equalize nominal tax payments across areas. Knoll and Griffith (2003) assume that a flat-tax on income does not change prices or reallocate resources; this assumption, as shown below, does not hold in general equilibrium.

Other work considers how tax deductions interact with local prices. Research by Gyourko and Sinai (2003, 2004) and Brady et al. (2003) tabulates how mortgage and local-tax deductions disproportionately benefit high-cost areas, but neglects how these deductions may offset the unequal burden of federal taxes from wage differences. Surveys of the possible benefits of tax deductions for mortgage interest (e.g. Glaeser and Shapiro 2003) or local taxes (e.g. Kaplow 1996) do not consider their inter-urban locational effects.

federal taxes, using the simulation. Considerable detail on theory, calibration, data, and extensions are left to the Appendix.

2 Theoretical Set-Up

To explain why prices and tax burdens differ across cities, I adapt the general-equilibrium model of Rosen (1979) and Roback (1980, 1982), incorporating federal taxes. The national economy is closed and contains many cities, indexed by j, which trade with each other and share a homogenous population of mobile workers. These workers consume a numeraire traded good, x, and a non-traded "home" good, y, with local price p^j. Cities differ in three types of exogenous attributes. Quality of life, Q^j, may be affected by amenities such as weather or safety. Productivity in the traded-good sector, A_X^j (or "trade-productivity"), may be due to natural advantages, like a harbor, or to agglomeration economies, such as input-sharing. Productivity in the home-good sector, A_Y^j, (or "home-productivity") may be affected by natural advantages or regulations affecting residential housing. The average value of each attribute is set to one.Although some city attributes may indeed be endogenous, it is safe to consider them exogenous if federal taxes do not significantly affect their relative levels across cities.

Firms produce traded and home goods out of land, capital, and labor. Factors receive the same payment in either sector. Land, L, is fixed in supply in each city at L^j, and is paid a city-specific price r^j. Capital, K, is fully mobile and is paid the price $\bar{\imath}$ everywhere. The supply of capital in each city is denoted K^j, with the aggregate level of capital fixed at K_{TOT}, thus $\sum_j K^j = K_{TOT}$. Labor, N, is also fully mobile, but because workers care about local prices and quality-of-life, wages, w^j, may vary across cities. Workers have identical tastes and endowments, and each supplies a single unit of labor. The total number of workers is fixed at N_{TOT}, so $\sum_j N^j = N_{TOT}$. Workers own identical diversified portfolios of land and capital, which pay an income $R = \frac{1}{N_{TOT}} \sum_j r^j L^j$ from land and $I = \bar{\imath}\frac{K_{TOT}}{N_{TOT}}$ from capital. Total income $m^j \equiv R + I + w^j$ varies across cities only as wages vary. Out of this income workers pay a federal income tax of $\tau\left(m^j\right)$. Deductions are introduced in Section 5.[2]

Workers' preferences are modeled by a utility function $U(x, y; Q)$ that is quasi-concave and homothetic over x and y, and increasing in Q. The corresponding expenditure function is $e(p, u, \tau(m); Q) \equiv \min_{x,y}\{x + py + \tau(m) : U(x, y; Q) \geq u\}$. Q is assumed to enter neutrally into the utility function and is normalized so that $e(p, u, \tau(m); Q) = [e(p, u) + \tau(m)]/Q$, where $e(p, u) \equiv e(p, u, 0; 1)$.Since workers are fully mobile, their utility must be the same across all inhabited cities, so that higher prices, lower quality-of-life, or higher taxes must be compensated with greater income:

$$\left[e(p^j, \bar{u}) + \tau(m^j)\right]/Q^j = m^j \tag{1}$$

$\bar{u}$ is the level of utility attained by all workers, regardless of each worker's federal tax burden.[3]

Operating under perfect competition, firms produce traded and home goods according to the functions $X = A_X F_X(L_X, N_X, K_X)$ and $Y = A_Y F_Y(L_Y, N_Y, K_Y)$, where F_X and F_Y are concave and exhibit constant returns to scale.[4] Unit cost in the traded-good sector is $c_X(r, w, i)/A_X \equiv \min_{L,N,K}\{rL + wN + iK : A_X F(L, N, K) = 1\}$.A symmetric definition holds for unit cost in the home-good sector, c_Y. All factors are fully employed: $L_X^j + L_Y^j = L^j$, $N_X^j + N_Y^j = N^j$, and $K_X^j + K_Y^j = K^j$. As markets are competitive, firms make zero profits in equilibrium, so that for given output prices, more productive cities pay higher rents and wages, so that following conditions hold in all cities j where production occurs:

$$c_X(r^j, w^j, \bar{\imath})/A_X^j = 1 \tag{2}$$

$$c_Y(r^j, w^j, \bar{\imath})/A_Y^j = p^j \tag{3}$$

[2]Because markets are perfectly competitive, the economic incidence is unchanged if the nominal incidence of taxes is placed on firms' labor costs, rather than on workers' wage incomes. Consumption taxes in this model are equivalent to income taxes; taxes on production are largely equivalent, except for the portion that falls on capital and land.

[3]The model generalizes to a case with workers that supply different fixed amounts of labor if these workers are perfect substitutes in production, have identical homothetic preferences, and earn equal shares of income from labor. More general types of worker heterogeneity are considered in Appendix D, including the case where some workers are immobile, or differ in their attachment to particular cities, simulating the effects of moving costs. This explains how federal tax changes can have redistributive effects across areas when tastes are heterogeneous or moving costs are substantial.

[4]Non-Hicks-neutral productivity differences have similar impacts on relative prices across cities, but not on relative quantities.

This analysis models a single federal government that collects tax revenues, makes transfers, and uses the net balance to buy traded goods that are transformed into a federal public good, such as defense. This federal public good benefits workers everywhere equally, and its level is held fixed. Federal taxes are modeled net of federal transfers.Naturally, federal means-tested benefits increase the effective marginal tax rate for some workers.[5] Additionally, it matters if federal tax payments are tied to federal transfers. In the United States, workers in high-wage areas pay more in payroll taxes, and then receive higher Social Security benefits later in life. Thus, the marginal benefit of paying these taxes should be subtracted from the effective marginal income tax rate.

The local public sector does not need to be modeled explicitly. If local government provides goods efficiently, as in the Tiebout (1956) model, these goods can be treated as consumption goods. Furthermore, efficiency differences across local public sectors may be subsumed into differences in Q^j (Gyourko and Tracy 1989, 1991) or A_Y^j. Taxes levied at the subnational level can also be distributed unequally across areas when wages vary within a subnational jurisdiction, such as a state, but not usually a county or municipality. State taxes are incorporated into the simulation below, where their effects are small; for expositional ease, they are ignored here.

For workers, denote the expenditure shares of traded goods, home goods, and taxes as $s_x^j \equiv x^j/m^j$, $s_y^j \equiv p^j y^j/m^j$, and $s_T^j = \tau\left(m^j\right)/m^j$; denote the shares of income received from land, labor, and capital income as $s_R^j \equiv R/m^j$, $s_w^j \equiv w^j/m^j$, and $s_I^j \equiv I/m^j$. For firms, denote the cost shares of land, labor, and capital in the traded-good sector as $\theta_L^j \equiv r^j L_X^j/X^j$, $\theta_N^j \equiv w^j N_X^j/X^j$ and $\theta_K^j \equiv \bar{\imath} K_X^j/X^j$; denote similar costs shares in the home-good sector as ϕ_L^j, ϕ_N^j, and ϕ_K^j. Assume, as is likely, that home goods are more cost intensive in land relative to labor than traded goods, i.e., $\phi_L/\phi_N > \theta_L/\theta_N$.

[5] This is complicated by eligibility requirements for programs which vary by state or county. Furthermore, some benefit levels are tied to local prices, such as housing programs, although these programs tend to be small. Insomuch as they are valued, local goods provided by the federal government may be treated as transfers, as can intergovernmental transfers that increase the supply of local government goods. It should be noted that federal matching rates for many programs (e.g. Medicaid) decline with average state income. The complicated nature of these transfers makes it useful to consider some types of federal transfers separately from an overall tax schedule, as in Section 6.4.

3 Price and Federal-Tax Differences across Cities

Federal taxes on labor income affect how prices vary cross-sectionally across cities with different attributes. To analyze this, assume that there are enough cities varying in the three city attributes, Q, A_X, and A_Y so we can treat these attributes as continuous variables. The equilibrium conditions (1), (2), and (3) implicitly define the prices w^j,r^j, and p^j — and the federal tax, $\tau(m^j)$, which depends on them — as a function of Q^j, A_X^j, and A_Y^j. These conditions may be log-linearized to express a particular city's price differentials in terms of its city-attribute differentials, each relative to the national average. These differentials are expressed in logarithms so that, for any variable z, $\hat{z}^j = \ln z^j - \ln \bar{z} \cong (z^j - \bar{z})/\bar{z}$, approximates the percent difference in city j of z relative to the geometric average $\bar{z}$. Values in the presence of income taxes are not subscripted; counterfactual values under a uniform, utility-equivalent lump-sum tax are subscripted by zero, e.g. $\hat{z}_0^j$.The change in z due to income taxes is denoted with a "d," so $dz^j = z^j - z_0^j$ and $d\hat{z}^j = \hat{z}^j - \hat{z}_0^j$. In an average city $\hat{z}^j = \hat{z}_0^j = d\hat{z}^j = 0$.

Log-linearized versions of (1), (2), and (3) describe how prices co-vary with city attributes.

$$s_w \hat{w}^j - s_y \hat{p}^j = \tau' s_w \hat{w}^j - \hat{Q}^j \tag{4a}$$

$$\theta_L \hat{r}^j + \theta_N \hat{w}^j = \hat{A}_X^j \tag{4b}$$

$$\phi_L \hat{r}^j + \phi_N \hat{w}^j - \hat{p}^j = \hat{A}_Y^j \tag{4c}$$

These equations are first-order approximations around a nationally-representative city and so the share values are national averages. Equation (4a) states how before-tax real income, given by the nominal income difference, $s_w \hat{w}^j$, net of the cost-of-living difference, $s_y \hat{p}^j$, compensates for lower quality of life, $-\hat{Q}^j$, and higher federal taxes, $\tau' s_w \hat{w}^j$. This last term is the income tax differential as a fraction of total income, $\tau' s_w \hat{w}^j = \tau' \hat{m}^j \equiv d\tau^j/m$, due to the wage differential $\hat{w}^j$.For example, if a city offers 10 percent higher wages, the share of income from wages is 75 percent, and the marginal tax rate is 33 percent, then workers of the city pay additional taxes equal to 2.5 percent of income. The effects of a federal tax differential are similar to that of a head tax on workers for living in city j, except that the federal tax differential depends on an endogenous wage differential, $\hat{w}^j$, rather than being set exogenously. Equations (4b, 4c) demonstrate how high productivity in each sector results in high factor prices relative to the output price in equilibrium.

The tax differentials depend on the wage differentials, which may be written

$$\hat{w}^j = \hat{w}_0^j + \underbrace{\frac{\theta_L}{\theta_N}\frac{1}{s_R}\overbrace{\tau' s_w \hat{w}^j}^{d\tau^j/m}}_{d\hat{w}^j} = \frac{1}{1-\frac{\theta_L}{\theta_N}\frac{s_w}{s_R}\tau'}\hat{w}_0^j \tag{5}$$

where the wage differential under a neutral, utility-equivalent, lump-sum tax

$$\hat{w}_0^j = \frac{1}{\theta_N s_R}\left(s_y\phi_L\hat{A}_X^j - \theta_L\hat{Q}^j - s_y\theta_L\hat{A}_Y^j\right) \tag{6}$$

relates how wages rise with trade-productivity and fall with quality-of-life or home-productivity. The first equality of (5) demonstrates that firms paying a positive wage differential without income taxes, $\hat{w}_0^j$, pay an additional wage differential, $d\hat{w}^j$, to help compensate for higher income taxes. The term multiplying $\hat{w}_0^j$ after the second equality exceeds one, meaning that income taxes increase wage differences across cities.[6]

Combining equations $d\tau^j/m = \tau' s_w \hat{w}^j$, (5), and (6), the tax differential in terms of city attributes is

$$\frac{d\tau^j}{m} = \tau'\frac{1}{1-\frac{\theta_L}{\theta_N}\frac{s_w}{s_R}\tau'}\frac{s_w}{\theta_N s_R}\left(s_y\phi_L\hat{A}_X^j - \theta_L\hat{Q}^j - s_y\theta_L\hat{A}_Y^j\right) \tag{7}$$

As do wages, federal taxes rise with trade-productivity and fall with quality of life or home-productivity. Spatially, the income tax operates as if the federal government supplemented a uniform lump-sum tax with a revenue-neutral system of head taxes, which vary across cities according to (7).

[6]The solution requires the identities $s_R = (s_x + s_T)\theta_L + s_y\phi_L$ and $s_w = (s_x + s_T)\theta_N + s_y\phi_N$..Expressions for price differentials without taxation equivalent to (6), (9a), and (9b) are found in Roback (1980). Those expressions are not log-linearized, and ignore non-labor income and the accounting identities.Gyourko and Tracy (1989) develop expressions similar to (5) and (8a) for wage and rent changes in the presence of local income taxes in the simpler case where $\phi_L = 1$. Their expressions look very different, as they are not log-linearized or simplified in the same way. These analyses do not refer to federal taxes or deductions.

Land rent and home-good price differentials can be decomposed similarly:

$$\hat{r}^j = \hat{r}_0^j - \underbrace{\frac{1}{s_R}\frac{d\tau^j}{m}}_{d\hat{r}^j} \tag{8a}$$

$$\hat{p}^j = \hat{p}_0^j - \underbrace{\left(\phi_L - \frac{\theta_L}{\theta_N}\phi_N\right)\frac{1}{s_R}\frac{d\tau^j}{m}}_{d\hat{p}^j} \tag{8b}$$

where the rent and price differentials under a utility-equivalent lump-sum tax are

$$\hat{r}_0^j = \frac{1}{s_R}\left(\hat{Q}^j + s_x\hat{A}_X^j + s_y\hat{A}_Y^j\right) \tag{9a}$$

$$\hat{p}_0^j = \frac{1}{\theta_N s_R}\left[\left(\theta_N\phi_L - \theta_L\phi_N\right)\hat{Q}^j + \phi_L s_w\hat{A}_X^j - \theta_L s_w\hat{A}_Y^j\right] \tag{9b}$$

Both land rents and home-good prices increase with quality of life and trade-productivity, although land rents rise and home-good prices fall with home-productivity. (8a) reveals how additional federal taxes are fully capitalized into land rents as $s_R \cdot m \cdot d\hat{r}^j = -d\tau^j$, which implies $dr^j \cdot L^j = -N^j \cdot d\tau^j$.[7] (8b) reveals how taxes are capitalized into the price of home goods, depending on their land intensity. Overall, taxes lower relative land and home-good prices in cities with higher trade-productivity, lower quality-of-life, or lower home-productivity.[8]

Workers are compensated for higher taxes through a combination of higher wages and lower home-good prices. Using the expression for $d\hat{w}^j$ in (5) it is possible to show that that the fraction

[7] If land is not shared equally across the population, increases in the marginal (but not average) tax rate benefits land owners in low-wage cities and hurts those in high-wage cities. Utilities cease to be equal across workers, but this does not change the resulting equilibrium if preferences are homothetic.

As home goods consist mainly of durable housing, supply of home goods could take time to adjust to this equilibrium in response to a tax change. In the short-run, the housing supply is relatively fixed. A way to model this is to augment the definition of "land" to include the housing stock, and to increase the effective cost shares ϕ_L and θ_L. In the short-run, housing-price changes are larger and employment changes smaller than in the long run.

[8] The effect of taxes on prices is sensitive to the assumption that attributes are exogenous. This is most conspicuous with respect to trade-productivity, which increases with overall employment because of agglomeration. Higher federal taxes cause employment to fall, lowering trade-productivity. This in turn lowers wages, home-good prices, and land rents, magnifying the effects for the latter two, while dampening (or possibly reversing)the effect on wages. A simplified example is shown in Appendix D. If quality-of-life falls (rises) with employment, then wage, rent, and price changes are dampened (magnified). If home-productivity falls (rises) with employment, then wage and price effects are dampened (magnified), while rent effects are magnified (dampened).

of taxes compensated through wages, $dw^j/d\tau^j$, equals λ_L/λ_N, denoting the ratio of the fraction of land in the traded goods sector, $\lambda_L \equiv (1-s_y)\,\theta_L/s_R$, to the fraction of labor in the traded sector, $\lambda_N = (1-s_y)\,\theta_N/s_w$. The less land is used in traded-good production, the less total costs fall when taxes cause land rents to fall, and thus the less wages increase, and the more lower land rents are passed on to workers through lower home-good prices. This ratio also determines how much quality-of-life advantages are reflected in lower wages rather than higher prices.[9]

The effect of federal taxes on local prices can be shown graphically by assuming that home goods are just land $(\phi_L = 1,\ A_Y = 1)$, so that $p = r$, and that initially workers everywhere pay a uniform lump-sum tax of T.Figure 1 illustrates the case of a highly trade-productive city, say Chicago (labeled "C"), and an average city, say Nashville, with productivities $A_X^C > 1$ and $\bar{A}_X = 1$. The zero-profit conditions slope downward as wages must fall as rents rise to keep profits at zero. More productive firms in Chicago pay higher wages or rents, placing its zero-profit condition to the upper-right of Nashville's. The worker-mobility condition slopes upwards as wages must rise with rents in order for workers to be indifferent between either city. In the tax-free equilibrium, shown at $\bar{E}$ and E_0^C, Chicago is more crowded than Nashville and pays workers a differential, $w_0^C - \bar{w}$, to compensate them for the higher cost-of-living reflected in $r_0^C - \bar{r}$.

Now replace the lump-sum tax with an income tax set so that workers with an average wage $\bar{w}$, pay the same amount of taxes, $\tau(\bar{w} + R + I) = T$, leaving utility unchanged, although now these workers face a positive marginal tax rate, $\tau' > 0$.With this positive marginal tax rate, workers in costlier cities must be paid more before taxes to receive the same compensation after taxes, rotating the mobility condition counter-clockwise around its intersection with the horizontal line at $\bar{w}$, to its slope of $y/(1-\tau')$. Workers in Chicago at the old equilibrium E_0^C are now worse off than in Nashville, as the old compensating differential does not make up for the higher costs and higher taxes. Workers will leave Chicago ($dN^C < 0$), lowering the demand for land in both production and consumption, causing rents to fall by dr^C, and raising the labor-to-land ratio, causing wages to rise by dw^C. At the new equilibrium, E^C, workers are no worse off in Chicago. Firms are no better

[9]How attributes are capitalized into local prices is discussed in greater detail in Albouy (2009).

off, since their cost savings in land are passed off to workers in higher wages. By making Chicago relatively more expensive, the income tax discourages workers from working there, similar to how taxes discourage work by raising the cost of effort relative to leisure.

The case of a city offering a higher quality-of-life, say Miami, is illustrated in Figure 2. Like Chicago, Miami is relatively crowded and has high rents, except that as compensation workers receive a nicer environment rather than a higher wage. Because land is fixed in supply and used in production, local labor demand curves are downward sloping; a larger supply of workers in the nicer city lowers the wage. This equilibrium is shown in Figure 2, with Nashville and Miami ("M"), each having qualities-of-life $\bar{Q} = 1$ and $Q^M > 1$. Both cities have the same productivity, and so share the same zero-profit condition. Yet, the mobility condition for workers in Miami is located to the lower-right, as workers are willing to accept lower wages or pay higher rents to live there. In equilibrium, shown in E_0^M, workers in Miami pay the rent premium $r_0^M - \bar{r}$, and give up the wage differential $w_0^M - \bar{w}$.

Replacing the lump-sum tax with an income tax, workers in Miami pay less tax as they earn below-average wages. A worker is more willing to bid down her wage to live in Miami, as a one dollar reduction in income implies only a $1-\tau'$ dollar reduction in consumption. With this effective tax-rebate for quality of life, workers in Miami are made better off. Workers are then induced to move to Miami ($dN^M > 0$) until rents are driven up by dr^M and wages are driven down by dw^M to make Miami no more attractive than other cities.To the extent that higher quality of life is bought through lower pre-tax wages, rather than higher post-tax home-good prices, its tax treatment is similar to untaxed fringe benefits: firms located in a city by the beach share tax advantages similar to firms that offer a tax-deductible company car.

The case of a more home-productive city, say Dallas ("D"), may be illustrated simplyby assuming $p = r/A_Y^D < r$, as $A_Y^D > \bar{A}_Y = 1$. Lower prices make Dallas workers better off for a given wages and rents, shifting the mobility condition to the lower right, as in Figure 2. In equilibrium, wages and home-good prices are lower than in Nashville, although rents are higher.Because Dallas workers are paid less, they have lower tax burdens, creating the same tax effects as in Miami.

Federal taxes on labor income may have many desirable properties, but their burden is curiously distributed across cities with different attributes. By falling more heavily on cities offering higher wages, federal taxes act like an arbitrary head tax for deciding to live in a city with wage-improving attributes, whatever those attributes may be. The tax is distortionary because workers are artificially attracted to cities that are nicer to live in, more home-productive, or less trade-productive. At a minimum, it would be preferable to charge an equivalent tax directly on land according to its wage-improving attributes: this would affect land rents in the same way, but would not distort location behavior or other prices.[10]

4 Employment Effects and Locational Efficiency

Federal taxes not only influence prices, but also cause factors such as labor to move across cities. By making high-wage cities more expensive to live in — or equivalently, more expensive to hire in — federal taxes induce workers to move away from high-wage areas towards low-wage areas, leading to an efficiency loss from misallocating workers across areas.

The employment effect of a differential tax can be written as

$$d\hat{N}^j = \varepsilon \cdot \frac{d\tau^j}{m} \tag{10}$$

where ε is the elasticity of local employment with respect to a local, uncompensated tax, written as a percent of total income. In principle, reduced-form estimates of this elasticity can be obtained. Furthermore, tax differentials can be obtained directly from data on wages and federal taxes. Thus, employment effects in (10) can be calculated without referring to a richer theoretical apparatus. Nevertheless, the theoretical model does imply a structural value for ε, which is given and derived in Appendix A.2.This elasticity is the sum of three long terms, each dependent on a different

[10]If labor supply is elastic the effect of federal tax differentials cannot be equated directly with head taxes. Real wages fall with quality of life, and so if labor supply increases with real wages, labor supply is lower in nicer cities, assuming quality of life and leisure are not substitutes. Thus, in nicer cities workers will work less, and thus avoid taxes even more, increasing the tax advantage that nicer cities have.

elasticity of substitution, and is unambiguously negative if $\phi_L/\phi_N > \theta_L/\theta_N$.

Because workers locate in response to federal income taxes, the resulting spatial distribution of employment becomes inefficient, or "locationally inefficient" (Wildasin 1980). In Appendix A.3, I derive the deadweight loss due to this inefficiency by calculating how much revenue the government loses when it replaces a neutral lump-sum tax with an income tax, holding the utility of workers constant. Consistent with Harberger (1964), this deadweight loss, expressed as a fraction of national income, is proportional to half the size of the tax differential times the induced change in migration, averaged across cities.

$$\frac{DWL}{\bar{m} \cdot N_{TOT}} = \frac{1}{2} E \left[\frac{d\tau^j}{m} d\hat{N}^j \right]$$

Whatever the distribution of city attributes, this formula captures the entire efficiency loss from all of the distortions created by unequal geographic taxation, including the indirect distortion on the location of capital. This does assume that city attributes are unaffected by employment levels. Furthermore, as $d\hat{N}^j = \varepsilon \cdot d\tau^j/m$, the deadweight loss can be calculated using only data on ε and the variance of income tax differentials:

$$\frac{DWL}{\bar{m} \cdot N_{TOT}} = \frac{1}{2} \text{Var} \left(\frac{d\tau^j}{m} \right) \cdot \varepsilon \tag{11}$$

Since $d\tau^j/m = \tau' s_w \hat{w}^j$, the deadweight loss increases with the variance of wage differences across cities.

5 Tax Indexation and Deductions

Since federal taxes make workers locate inefficiently, it is worth considering policies to remedy this problem. Taxes can be indexed to either local wages or local costs:the former is better in theory, but arguably harder to implement, while the latter over-subsidizes life in nicer locations. If demand for home goods is inelastic, tax deductions for home-good expenditures effectively index taxes partially to local costs.

5.1 Wage-Level and Cost-of-Living Indexation

Income taxes may be indexed to wages by dividing taxable labor income by the "pay relative" $1+\hat{w}^j = w^j/\bar{w}$, assuming those pay relatives can be correctly measured. With this indexation, a worker's federal taxes do not depend on where she lives, effectively turning the income tax into a neutral lump-sum tax.

Indexing taxes to local cost-of-living may be easier than indexing taxes to wages as the prices of homogenous goods across cities may be easier to measure than the prices of homogenous units of labor. Presumably, taxes would be indexed to local costs by dividing income by an index $\kappa(p^j)$ — one that ignores quality of life — resulting in taxes $\tau = \tau\left(m^j/\kappa\left(p^j\right)\right)$. An ideal cost-of-living index of this kind is defined in terms of gross expenditures: $\kappa\left(p^j\right) = \left[e\left(p^j,\bar{u}\right)+\bar{\tau}\right]/\left[e\left(\bar{p},\bar{u}\right)+\bar{\tau}\right]$, where $\bar{p}$ and $\bar{\tau}$ are the average home-good price and tax burden.

With cost indexation, the tax differential in a city increases with wages and decreases with home-good prices according to the formula $d\tau^j/m = \tau'\left(s_w\hat{w}^j - s_y\hat{p}^j\right)$. This changes the mobility condition (4a) to

$$s_y\hat{p}^j - s_w\hat{w}^j = \hat{Q}^j/\left(1-\tau'\right) \tag{12}$$

With cost-indexed taxes workers are willing to take a larger fall in pre-tax real income to improve their quality-of-life.Substituting (12) into $d\tau^j/m = \tau'\left(s_w\hat{w}^j - s_y\hat{p}^j\right)$ reveals that cost-indexed taxes depend only on local quality-of-life.

$$\frac{d\tau^j}{m} = -\frac{\tau'}{1-\tau'}\hat{Q}^j \tag{13}$$

Relative to taxation without indexation, cost indexation eliminates tax differences across cities differing in either type of productivity (A_X or A_Y); across these cities, wages rise in step with costs. Thus, indexing with costs is equivalent to indexing with wages. The drawback to cost indexation is that in nicer cities workers receive two tax advantages: they owe fewer taxes for paying higher prices and for receiving lower wages. The government then massively subsidizes life in nicer cities. While this may sound like a welfare improving policy, it would actually reduce welfare as nicer cities would become overcrowded.

5.2 Tax Advantages for Housing and Local Taxes

Thus far, I ignored that the federal tax code confers a number of advantages to housing and goods provided by local government. Home-owners benefit from a number of tax advantages in housing consumption as they are not taxed for the rent they implicitly "pay" themselves when living in their own home, and as they can deduct mortgage interest from their income taxes (see Rosen 1985, Poterba 1992). Goods provided by local governments are also subsidized by the federal government, as local and state taxes can be deducted from federal taxes. Since housing and most locally-provided government goods, such as education and public safety, are produced locally, these tax advantages may be thought to apply primarily to home goods.Together, these advantages may be modeled by allowing households to deduct a fraction $\delta \in [0,1]$ of home-good expenditures, py, from their federal income taxes, so that taxes paid are $\tau\left(m^j - \delta p^j y\right)$. δ should be less than 1 as these advantages do not apply to certain taxes (e.g. payroll) or to certain home goods, such as haircuts or restaurant meals. Nor are these advantages available to all workers: many renters and home-owners do not itemize deductions for mortgage interest or local taxes.

Totally differentiating the tax schedule, the additional tax paid by workers in a city depends positively on the wage and negatively on the home-good price and consumption level:

$$\frac{d\tau^j}{m} = \tau' \cdot \left[s_w \hat{w}^j - \delta s_y \left(\hat{p}^j + \hat{y}^j\right)\right] \tag{14}$$

Because utility is constant across cities, y falls with p according to the compensated own-price elasticity for home goods, $\eta^c < 0$, and with higher quality-of-life, so that $\hat{y}^j = \eta^c \hat{p}^j - \hat{Q}^j$. With a price increase of $\hat{p}^j$, the home-good expenditure share increases by $s_y\left(1 - |\eta^c|\right)\hat{p}^j$. Thus, the tax differential with deductions is

$$\frac{d\tau^j}{m} = \tau' s_w \hat{w}^j - \delta\tau' s_y (1 - |\eta^c|)\hat{p}^j + \delta\tau' s_y \hat{Q}^j \tag{15}$$

With the deduction, the tax differential in (15) depends on two additional effects:

Partial-Indexation Effect The term $-\delta\tau' s_y \left(1 - |\eta^c|\right) \hat{p}^j$ describes how taxes change with an increase in the compensated home-good price. If $|\eta^c| < 1$ workers in high-cost areas claim larger deductions, producing an implicit form of price indexation.

Quality-of-Life Income Effect The term, $\delta\tau' s_y \hat{Q}^j$, reflects that in nicer cities, workers face higher home-good prices without being compensated by higher wages. Residents of nicer areas consume less of all goods, including home goods. With higher Q, home-good expenditures fall by more than the partial-indexation effect implies, leading to fewer tax deductions.[11]

The full dependence of this tax differential on $\hat{A}_X^j$, $\hat{A}_Y^j$, and $\hat{Q}^j$ is in Appendix equation (A.17). With deductions, workers in cities with high trade-productivity or low home-productivity still pay higher-than-average taxes because the primary wage-tax effect dominates the partial-indexation effect. It is ambiguous whether workers in nicer cities pay relatively lower taxes with a deduction: the quality-of-life income effect may override the partial-indexation effect and the wage-tax effect combined, so that tax burdens could rise with quality-of-life. The calibration below suggests that taxes still fall with quality-of-life.[12]

6 Simulation of Tax Differences across the United States

The theoretical model above may be used to simulate the effects of differential federal taxation on prices, employment, and welfare across the United States. This requires calibrating the economic

[11] For the reduction in home-goods consumption to be proportional to s_y, I assume no complementarities between y and Q, and that the elasticity of y to income, $\eta_{y,m}$ is equal to one. If $\eta_{y,m} \neq 1$ then the quality-of-life income effect is $\delta s_y \eta_{y,m} \hat{Q}$. If y and Q are complements (substitutes), then the effect is smaller (larger).

[12] The effect of federal taxes on prices or employment with cost-of-living indexation or deductions is determined by substituting $d\tau^j/m$ from (13) or (15) into equations (5),(8a), (8b), and (10).

parameters of the model and estimating wage, housing-cost, federal spending, and quality-of-life differentials across metropolitan areas.

6.1 Calibrating the Model

An overview of the calibration is presented here, with greater detail left to the Appendix B. Alternative calibrations are considered in several sensitivity checks. Given that parameters are known with limited certainty, I use round fractions for ease.

Looking first at income shares, labor, s_w, receives 75 percent of income; capital, s_I, 15 percent; and land, s_R, 10 percent. Housing cost differences are used to measure home-good price differences. Using this measure requires that the expenditure share for home goods equals the expenditure share on housing of 22 percent *plus* the estimated expenditure share on non-housing home goods of 14 percent, to produce $s_y = 0.36$ — see Albouy (2008) for details. From national accounts, the government expenditure share, s_T, is 15 percent. The cost shares depend on a number of sources discussed in the Appendix. For traded goods, the cost-share of land, θ_L, is 2.5 percent, the cost share of capital, θ_K, is 15 percent, and the cost share of labor, θ_N, is 82.5 percent. For home goods, the cost-share of land, ϕ_L, is 23 percent, the cost share of capital, ϕ_K, is 15 percent, and the cost share of labor, ϕ_N, is 62 percent. The cost and expenditure shares are consistent with the income shares, and imply that the ratio λ_L/λ_N, which determines the fraction of taxes capitalized into wages, is equal to 23 percent.

The compensated own-price elasticity of demand for home-goods, η^c, is taken from studies detailed in the Appendix, with estimates that center around -0.5. The elasticity of employment with respect to local taxes, ε, is taken at -6.0 based on two methods, each yielding similar estimates. The first is to use direct reduced-form estimates of ε from Bartik's (1991) meta-analysis of the effect of local taxes on local levels of output and employment, controlling for local public spending. The second is to infer ε by directly calibrating a derived theoretical equation for employment changes, shown in Appendix B.2, using the above parameters, as well as elasticities of substitution taken from the literature.

The marginal federal income tax rate on gross wages, τ', of 33.3 percent is equal to the average marginal tax rate from TAXSIM (Feenberg and Coutts 1993) of 25.1 percent plus the marginal payroll tax rate on both the employer and employee sides, net of additional Social Security benefits (Boskin et al. 1987) of 8.2 percent. The federal deduction level, δ, is set at 0.257, which is far less than one because of renters, non-itemizing owners, non-housing home goods, and the inability to deduct from payroll taxes.[13]

Furthermore, I also include state-tax differentials due to the fact that wages, and hence state tax burdens, vary within state, even though state services do not. Taking into account federal deductions, state taxes (including income and sales taxes) increase the effective marginal tax rate on wages by 6.2 percentage points, on average, ranging from 0 points in Alaska to 8.8 percent in Minnesota. However, wage differences within state are only 44 percent as large, on average, as wage differences within the entire country.Thus, total tax differences may be approximated by increasing the federal marginal tax rate by $6.2 \times 0.44 = 2.7$ points to 36 percent. Exact state tax differentials are calculated by multiplying the within-state wage differential by the corresponding state tax rate, and also account for state deductions for housing. Formulas to incorporate state taxes are presented in Appendix A.

6.2 Estimates of Wage, Price, and Spending Differentials

Wage and home-good price differentials are estimated using 5 percent samples of Census data from the 2000 Integrated Public Use Microdata Series (IPUMS). Home-good price differentials are based on housing costs, as they are a prime determinant and predictor of cost-of-living differences.Cities are defined at the Metropolitan Statistical Area (MSA) level using 1999 OMB definitions.Consolidated MSAs are treated as a single city (e.g. San Francisco includes Oakland and San Jose), as are the non-metropolitan areas of each state. This classification produces a total of 241

[13] Effects of a progressive tax system were also explored. A progressive tax schedule increases the variance of tax differentials, increasing the associated deadweight loss in (11).Because wage differentials are small relative to the tax schedule, they lead to only moderate changes in tax rates. A generous calculation produced at most a 5 percent increase in the deadweight burden calculation.

cities, and 49 state-level collections of non-metropolitan areas. More details are given in Appendix C.

Inter-urban wage differentials, w^j, are calculated from the logarithm of hourly wages for full-time workers, ages 25 to 55. These differentials control for skill differences across workers to provide an analogue to the representative worker in the model. Thus, log wages are regressed on city-indicators, μ_j^w, and on extensive controls, X_{ij}^w — each fully interacted with gender —for education, experience, race, occupation, industry, and veteran, marital, and immigrant status, in an equation of the form $\ln w_{ij} = X_{ij}^w \beta^w + \mu_j^w + \varepsilon_{ij}^w$. The estimates of μ_j^w are used as the wage differential for city j, and are interpreted as the causal effect of city j's attributes on a worker's wage. Identifying these differentials requires that workers do not sort across cities according to their unobserved skills. This assumption may not hold completely: Glaeser and Maré (2001) argue that up to one third of the urban-rural wage gap could be due to selection, suggesting that at least two thirds of wage differentials are valid, although this issue deserves greater investigation. At the same time, it is possible that the estimates could be too small, as some control variables, such as occupation or industry, could depend on where the worker locates.[14]

Housing values and gross rents reported in the Census are used to calculate home-good price differentials, $\hat{p}^j$. To reduce measurement error from imperfect recall or rent control, the sample includes only units that were acquired in the last ten years. Price differentials are calculated in a manner similar to wage differentials, using a regression of rents and values on flexible controls — interacted with tenure — for size, rooms, acreage, commercial use, kitchen and plumbing facilities, type and age of building, and the number of residents per room.Proper identification of housing-cost differences requires that average unobserved housing quality does not vary systematically across cities.[15]

[14]Obviously workers do not all have the same endowments and tastes or pay the same marginal tax rate, nor are they equally sensitive to productivity differences. However, as shown in Appendix D, workers with different tastes and endowments can be aggregated without serious complications, so long as each is weighted by their share of income (which is done, although it has little impact on the estimates). Furthermore, many workers report receiving little income other than labor income. However, given the static nature of the model, a worker's choices should be modeled to account for a worker's permanent income, which includes a large non-labor component, particularly if implicit rental earnings from one's own home are included.

[15]Malpezzi et. al. (1998) determine that similar housing-cost indices derived from the Census perform as well or

Table 1 presents wage and housing-cost differentials in 2000 for selected metro areas, and by Census division and metropolitan size. Figure 3 graphs wage differentials against housing-cost differentials for all metro areas and non-metro areas. Most large cities have above-average wages and housing costs; and, across cities of the same size, wages and costs tend to be higher in the Northeast and the Pacific. Overall, wages and housing costs are positively correlated, as reflected in the regression line.

As seen in equation (15), the calculation of tax differentials with the deduction requires quality-of-life estimates, $\hat{Q}^j$, which reported in Table 1. These are inferred from a mobility condition in Appendix A.4, similar to (4a) except that it accounts for the deduction. Their inference can be seen in Figure 3 using the drawn mobility condition across cities with average quality of life:$\hat{Q}^j$ in a particular city depends on how far its marker is to the right of this condition. Also shown is a zero-profit condition for firms for an average city where $\hat{A}_X^j = \hat{A}_Y^j = 0$. Without data on land rents, trade and home-productivity differences are not separately identified — they do not need to be for this simulation — although cities above this condition have either high trade-productivity or low home-productivity.[16]

To investigate federal spending differentials, data is taken from the Consolidated Federal Funds Report (CFFR), available from the U.S. Census of Governments. Spending is divided into three categories: (i) government wages and contracts, (ii) benefits to non-workers, and (iii) other spending. The first category consists of federal government purchases of goods and labor services; if these purchases are made at cost, they should not be considered transfers.[17] The second category includes spending that benefits individuals who are typically inactive in the labor market, such as retirees and full-time students, including Social Security and Medicare. The remaining category

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better than most other indices. Because home-good prices have only a minor effect on tax differentials, and as rent and housing-price differentials are highly correlated, the simulation is not very sensitive to how housing-cost differentials are estimated.

[16]The slope of the mobility condition is $s_y \left[1 - \delta\tau' \left(1 - |\eta^c|\right)\right] / \left[s_w \left(1 - \tau'\right)\right]$ and the slope of the zero-profit condition is $-\theta_L / \left(\theta_N \phi_L - \theta_L \phi_N\right)$. The capitalization of a quality-of-life improvement or a federal tax reduction (modeled as a head tax) on wages and housing prices is illustrated by shifting the mobility condition to the right. The capitalization of an increase in firm-productivity or a decrease in home-productivity is modeled by shifting the zero-profit condition to the right. Quality-of-life and productivity estimates are presented and explained in Albouy (2008) and Albouy (2009).

[17]Weingast et al. (1981) explains when localized spending should be treated as a transfer.

of other spending is more likely to benefit workers according to their location:it includes most government grants, such as for welfare, Medicaid, infrastructure, and housing subsidies. Spending differentials are adjusted to control for a limited set of population characteristics in a city, such as average age and percent minority, to provide a spending differential applicable to a representative worker. The adjusted differentials for other spending are reported as a fraction of household income in Table 1.

6.3 Tax Differences and Their Effects

Using the base calibration and estimates of $\hat{w}^j$, $\hat{p}^j$, and $\hat{Q}^j$ for 2000, Table 2 reports estimates of tax differentials and their effects across selected cities, and by Census division and metropolitan size. A full list is provided in Appendix Table A1. The three components of the federal tax differential from (15) are in the first three columns, with the totals in column 4. State tax differentials are in column 5, and the sum of federal and state tax differentials in column 6. A kernel density estimate of these total tax differentials is drawn in Figure 4.

The unequal distribution of taxes is substantial: the mean absolute deviation of federal tax differentials equals 2.6 percent of income, and with state taxes this rises to 2.8 percent. Starting at an average federal tax rate of 17 percent, a worker moving from a typical low-wage city to a typical high-wage city sees her average tax rate rise from 14.4 percent to 19.6 percent, paying over 30 percent more in federal taxes.Although tax differences are compensated for in local prices, this represents a horizontal transfer of $300 billion (in 2008) from workers in high-wage areas to similarly-skilled workers in low-wage areas.[18]

According to the simulation, the tax differential from equation (15) is given numerically by $d\tau^j/m = 0.271\hat{w}^j - 0.017\hat{p}^j + 0.040\hat{Q}^j$. Tax differences are driven largely by wage differences, although price and quality-of-life differences have some effect. Substituting in in the numeric

[18] The average federal tax rate of 17 percent includes federal income taxes and payroll taxes, appropriately adjusted (Congressional Budget Office 2003). Multiplying the mean absolute deviation of federal tax differentials, 0.259, by personal income in 2008 of $12.11 trillion produces a figure of $313 billion. Using GDP produces $369 billion, or AGI, $220 billion.

expression for $\hat{Q}^j = -0.492\hat{w}^j + 0.352\hat{p}^j$, reduces the tax differential to $d\tau^j/m = 0.254\hat{w}^j - 0.005\hat{p}^j$. Empirically, the deductions tend to reduce tax differences across areas. The partial-indexation effect tends to lower taxes in high-wage areas, while the quality-of-life effect typically offsets the partial indexation effect slightly. Figure 4 shows how eliminating the deduction would change the distribution of federal taxes across cities, increasing the tax differential gradient by 12 percent.Thus, without the deduction, the average tax differential would be 3.1 percent, making the distribution of federal taxes even more unequal.[19]

Each city's tax differential depends on its attributes according to the numeric analogue of equation (7) $d\tau^j/m = -0.092\hat{Q}^j + 0.271\hat{A}_X^j - 0.029\hat{A}_Y^j$.Thus, federal taxes depend most on a city's trade-productivity, and somewhat less on its quality of life and home-productivity. Tax burdens are highest in large cities in the Northeast, Midwest, and Pacific, while most small towns and non-metropolitan areas, particularly in the South, receive a large tax break. This appears to have more to do with productivity differences than quality-of-life differences: the average tax differential from quality-of-life differences alone would be only 0.4 percent, while the average from productivity differences alone would be 3.0 percent.

The totaltax differentials are considerable relative to typical differences in local taxes. Any local official would consider a permanent three-percent tax on local residents without any compensating services to be a fiscal calamity. Yet, central governments are imposing this situation on cities like Chicago, New York and San Francisco. On the other hand, an unconditional grant of three percent of income in perpetuity dwarfs almost any pork-barrel project. Relative to the national average, this is what workers in cities like Norfolk and Oklahoma City, as well as most non-metropolitan areas, effectively receive from the federal government.

These large tax differentials have considerable effects on prices and employment, seen in the last four columns Table 2. For example, the additional taxes paid to Washington and Albany by New York City raise wages by 1.6 percent, lower long-run housing costs by 11 percent, and lower land values by 41 percent. The employment effect is especially striking, stating that employment

[19] Since the existing tax system has a deduction, the tax differentials with no deduction are based on the counterfactual wage without a deduction; this wage can be determined from the model.

is 27 percent lower than in an undistorted equilibrium. This effect may seem too large, but it may be reasonable in the long run, as sizable federal taxes first affected average workers in World War II. The rise of the income tax is certainly consistent with the migration of people and jobs over the last sixty years from the high-wage "rust-belt" to the low-wage "sun-belt" (Kim and Margo, 2004).

The nationwide effects for a number of different calibrations are given in Table 3. The economic and tax parameters of these calibrations are displayed in the first panel, followed by the mean absolute deviations in outcomes, and the deadweight loss of taxation throughout the economy. All effects are averaged using the total population size of each area as weights.

The benchmark case, shown in column 1, reveals the overall significance of differential federal taxation nationwide. In a typical high-wage city, workers pay 2.8 percent more of their income in taxes, which causes land values to be 28 percent lower. Workers are compensated for the tax differential through a 0.9 percent increase in wages, increasing their pre-tax incomes by 0.6 percent, and a 6.0 percent reduction in the housing prices, reflecting a cost-of-living reduction of 2.2 percent. Thus, workers are compensated for tax differences more through costs than through wages.

The employment effect is quite large at 17 percent. Taken together, the employment effects create a substantial deadweight loss of about 0.33 percent of income a year, or $40 billion in 2008. As these numbers are based on a calibrated model, they should not be taken as absolute truth, but they do provide a sense of the magnitude of the impacts and costs caused by the uneven distribution of federal taxes.[20]

Alternative calibrations in Table 3 are shown in columns to the right. In column 2, all land is devoted to home-good production, keeping the total share of income to land constant: in this case, wage differentials are unaffected by taxes while home-good price differentials are affected more. In column 3, the cost shares of land in both sectors are reduced by one-half, with mobile capital taking up the remaining costs; this doubles the impact on land rents, without changing any of the other quantities.

[20] In the base calibration, agglomeration effects could dampen the positive effect of taxes on wages.According to Rosenthal and Strange (2004), the elasticity of wages with respect to population size due to agglomeration is not likely to be more than 5 percent. At this level, a 17 percent reduction in employment from taxes reduce wages by 0.9 percent, which would offset the 0.9 percent predicted increase in wages due to higher land-to-labor ratios.

Column 4 shows that if ε is -9.37, which corresponds to when production and utility are Cobb-Douglas, the employment effects and deadweight loss are increased proportionally. Column 5 demonstrates that if η^c is zero, then tax differentials are reduced substantially, as the partial-indexation effect from the home-good deduction is stronger. Column 6 cuts wage differentials down to two-thirds their original size, in case unobserved selection makes the estimated differentials too large: this lowers the differential taxes, price and employment effects by a third and deadweight-loss by five ninths. Column 7 reveals that if the deduction is ignored, measured tax differentials are larger. Finally, column 8 looks at the effect of federal taxes only, ignoring state taxes. Since federal taxes account for 92 percent of tax differences, the effects are only slightly smaller.

6.4 The Distribution of Federal Spending

The unequal burden of federal taxation would be much less of an issue if it was compensated for by federal spending differences.To explore this possibility, Table 4 reports coefficients from regressions of spending differentials, both raw and adjusted, on tax differentials in 2000. In the raw differentials there is a positive correlation with federal purchases (wages & contracts), a negative correlation with non-worker benefits, and no correlation with other spending, the category closest to a locational transfer. Once population characteristics are controlled for, correlations for wages and contracts and non-worker benefits become negative and insignificant, while other spending, as well as aggregate spending, becomes negatively correlated with federal tax differentials.

Figure 5, which graphs "other spending" differentials against tax differentials, makes it clear that federal spending does not offset differences in federal taxation. Although the federal government makes greater purchases in areas with higher wages, this arises from its need to purchase skilled labor. Column 9 of Table 3 simulates the effects of tax differentials net of other spending: these differentials have slightly larger variance, increasing the deadweight loss by a small amount. Overall, these results establish that federal spending patterns do not offset the pattern of differential taxation — if anything, they seem to exacerbate this pattern.

7 Simulating Tax Reforms

The simulation above can also be used to simulate the potential benefits of tax reforms that would affect the geographic distribution of federal taxes, such as wage or cost indexation, or eliminating the tax advantages of owner-occupied housing. The idea of indexing taxes or transfer programs to local prices is not foreign to policy makers in Washington. U.S. members of Congress have proposed, but not passed, legislation to index taxes and transfers to regional cost-of-living repeatedly: the Tax Equity Act, to index taxes, the Poverty Data Correction Act, to index the poverty line, and the COLA Fairness Act, to index Social Security payments. Some programs are already indexed to local prices, although most are not. Federal Housing Administration loan insurance is guaranteed up to the level of local median home prices. Department of Housing and Urban Development (HUD) public housing and rental vouchers programs use local metropolitan-area income levels to determine eligibility, in combination with a local index of "Fair Market Rents" to determine benefits.

Economists have put more attention on the idea of reforming tax advantages for owner-occupied housing and local taxes. The President's Advisory Panel on Federal Tax Reform (2005) recommended cutting tax deductions for local taxes and home-mortgage interest, which would raise taxes disproportionately in high-cost areas (Anderson et al. 2007). Yet, The Panel also suggested that mortgage-interest deductions be capped according to local housing prices, which implicitly provides some cost-of-living adjustment in the tax code. More specifically, if home-mortgage deductions are capped according to local-housing prices, one of two outcomes will occur. If home-owners purchase below the cap, the effect of the deductions does not change. If home-owners purchase above the cap, the deduction has effects similar to direct cost-indexation, as residents in high-cost areas receive a tax rebate proportional to the local housing costs. The degree of this indxation effect depends on how close the cap is to actual housing expenditures, and on the proportion of cost-of-living differences that depend on housing.

Of course, eliminating deductions would raise the after-tax price of purchasing housing and local-government goods through local taxes. This would be the ostensible purpose of the reform, as home-owners would be treated more like renters, and would no longer have an incentive to consume housing or local-government goods at an inefficiently high level. This distortion, already heavily studied in the housing market is thought to cause significant welfare losses (e.g. Rosen 1985, Poterba 1992). While it may be desirable to eliminate deductions to prevent the overconsumption of certain goods, changes in locational efficiency should also be taken into account when considering such a reform.[21]

An added complication of simulating the tax reforms is that it is possible for wage or cost-indexation to occur with or without the tax advantages for housing and local taxes in place. Therefore, we first consider the effects of changing these tax advantages before looking at the effects of indexation, with and without these advantages. Seven different reforms are examined in Table 5, which reports the average tax differentials and the deadweight losses due to the locational inefficiency of workers and consumption inefficiency due to the overconsumption of housing and local-government goods[22] All reforms are based on the benchmark calibration with the status quo shown in column 0, which shows that welfare losses due to locational inefficiency and to consumption inefficiency are almost of the exact same size, or 0.3 percent of income – an intriguing finding, suggesting that locational inefficiencies have been understudied relative to consumption inefficiencies.

Columns 1 and 2 examine the consequences of eliminating the deduction entirely, with the second reform reducing the marginal tax rate so that the overall reform is revenue neutral. Both reforms eliminate the welfare loss from consumption inefficiency. Without the tax cut, eliminating the deduction would raise taxes in high-wage cities and increase locational inefficiency, but with

[21]If the intention of the cap is to induce individuals to own a home, without inducing them to consume too much housing, then the cap should be set to less than the typical housing price. To deal with income heterogeneity, the cap could also change with income as well as location.

[22]This deadweight loss is given by the formula $0.5\eta^c s_{hous} f_{item}(\delta_{hous}\tau')^2$ where s_{hous} is the fraction of expenditures spent on housing, f_{item} is the fraction of households who itemize, and δ_{hous} is the deduction level applicable to housing. Note that δ is set so that $s_{hous} f_{item}\delta_{hous} = s_y\delta$.

Technically, this formula does not apply to this setting as it is based on a partial equilibrium analysis with a perfectly elastic supply of housing. The setting here is in general equilibrium with an imperfectly elastic supply of housing, as land is fixed in supply. Incorporating these supply conditions, using the standard Harberger (1962) approach, reduces the effective elasticity, and the deadweight-loss, by approximately 10 percent. The formula also assumes that there are no pre-existing distortions in the housing market, such as those due to property taxes.

the tax cut the locational inefficiency would be the same as in the status quo. Thus, the tax advantages reduce locational inefficiencies if the tax rate is held fixed, but are close to locationally neutral if accompanied with an offsetting decrease in overall tax rates. In column 3, the deduction is increased to 100 percent and applied to all goods that vary in price across location, but is also accompanied by significant tax hike to keep revenues constant. This reform reduces locational inefficiency by a small amount, but creates a very large increase in consumption inefficiency.

Column 4 presents the case where taxes are indexed to local wages and the deduction is eliminated with an offsetting tax reduction: in this ideal case neither inefficiency arises. In column 5, taxes are indexed to local costs, while the deduction is eliminated: interesting this proves to improve locational efficiency relative to the comparable situation in column 2 without indexing. As mentioned in Section 5.1, cost-indexation reduces ta differences between areas than differ in productivity but increases them between areas that differ in quality of life: empirically, the former effect dominates the latter — a very interesing finding. Columns 6 and 7 index taxes to wages and cost-of-living with the deduction in place. With wage-indexation and the deduction, a slight locational inefficiency arises solely because of the deduction.[23] In column 7, the locational benefits of cost-indexation are greatly reduced, since nicer areas are even more heavily subsidized. Thus, it appears that if tax advantages for housing and local taxes are kept in places, then cost-indexation would do little to improve locational efficiency, while wage-indexation would do so significantly.

8 Conclusion

Any tax on labor income creates an incentive for workers to leave high-wage areas in favor of low-wage areas. Even though mobile workers should be compensated for the resulting tax differences through adjustments in local prices and wages, the resulting geographic distribution of employment will be distorted, causing a substantial welfare loss.

The simulated effects of federal taxes on prices, employment and welfare are based on the

[23] If there were no true wage differences across cities to produce the wage-tax effect, this number could be added to the deadweight loss from the favorable tax-treatment of home goods.

assumption that city attributes are unaffected by population movements. When city attributes are affected by population size, these effects could be smaller or larger than predicted. Furthermore, the distribution of city sizes may no longer be optimal even in the absence of federal taxes, which could ameliorate or aggravate pre-existing distortions. Given the complexities of dealing with endogenous attributes, these issues are left for further work.

Politicians who represent high-wage areas may legitimately complain that their districts pay a disproportionate share of federal taxes. However, in most countries, reforms to equalize the federal tax burden across areas would likely meet fierce political opposition. In the United States, highly-taxed areas tend to be in large cities inside of populous states, which have low Congressional representation per capita, making the prospect of reform daunting. In other countries, such as Canada, rural areas also receive disproportionate representation in national legislatures. Nevertheless, when considering federal tax reforms, policy-makers should be aware of their spatial consequences on local prices, employment, and welfare.

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TABLE 1: WAGE, HOUSING-COST, QUALITY-OF-LIFE, AND FEDERAL-SPENDING DIFFERENCES ACROSS AREAS, 2000

		Adjusted Differentials			
	Pop. Size	Wage (1)	Hous. Cost (2)	QOL (3)	Fed. Spend (4)
Metro Area					
San Francisco, CA	7,039,362	0.26	0.75	0.13	0.011
New York, NY	21,199,865	0.21	0.42	0.04	-0.003
Detroit, MI	5,456,428	0.13	0.09	-0.04	-0.009
Chicago, IL	9,157,540	0.14	0.22	0.01	0.001
Hartford, CT	1,183,110	0.15	0.15	-0.03	0.003
Boston, MA	5,819,100	0.14	0.35	0.05	0.000
Washington, DC	7,608,070	0.13	0.17	-0.01	0.006
Philadelphia, PA	6,188,463	0.13	0.40	0.07	-0.003
Los Angeles, CA	16,373,645	0.12	0.07	-0.04	0.003
Minneapolis, MN	2,968,806	0.09	0.06	-0.02	-0.019
Jacksonville, FL	1,100,491	-0.07	-0.09	0.01	0.006
San Antonio, TX	1,592,383	-0.09	-0.19	-0.02	-0.005
Oklahoma City, OK	1,083,346	-0.12	-0.21	-0.01	-0.006
Norfolk, VA	1,569,541	-0.11	-0.07	0.03	-0.013
Joplin, MO	157,322	-0.25	-0.42	-0.02	-0.008
Census Division					
Pacific	45,042,272	0.10	0.36	0.08	0.001
Middle Atlantic	39,668,438	0.08	0.11	0.00	0.000
New England	13,928,540	0.07	0.18	0.03	-0.002
East North Central	45,145,135	0.00	-0.09	-0.03	-0.003
South Atlantic	51,778,682	-0.03	-0.06	-0.01	-0.001
Mountain	18,174,904	-0.05	0.02	0.03	0.002
West South Central	31,440,101	-0.07	-0.21	-0.04	0.001
West North Central	19,224,096	-0.11	-0.25	-0.03	0.006
East South Central	17,019,738	-0.12	-0.30	-0.04	0.000
Metro Population					
Pop > 5 Million	81,606,427	0.16	0.32	0.03	0.000
Pop 1.5-4.9 Million	55,543,090	0.03	0.05	0.00	-0.005
Pop 0.5-1.4 Million	40,499,870	-0.03	-0.07	-0.01	0.000
Pop < 0.5 Million	36,417,747	-0.09	-0.15	-0.01	-0.002
Non-Metro Areas	67,354,772	-0.14	-0.28	-0.03	0.005
US Standard Dev		0.13	0.29	0.05	0.011
US Mean Abs Dev		0.11	0.24	0.04	0.008

TABLE 2: TAX DIFFERENTIALS ACROSS AREAS AND THEIR EFFECTS ON PRICES AND EMPLOYMENT, 2000

Tax Pay-ment Rank		*Federal Tax Differential*				State Tax Differ-ential	Total Tax Differ-ential	*Total Tax Differential Effects*			
			Deduction Effects								
		Wage Effect	Partial Index	QOL Income	Total Federal			Wage	Hous. Cost	Land Rent	Employ-ment
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Metro Area										
1	San Francisco, CA	0.068	-0.012	0.005	0.061	0.007	0.068	0.020	-0.145	-0.676	-0.406
2	New York, NY	0.054	-0.007	0.002	0.049	0.004	0.053	0.016	-0.113	-0.527	-0.316
3	Detroit, MI	0.035	-0.001	-0.001	0.032	0.004	0.036	0.011	-0.078	-0.365	-0.219
4	Chicago, IL	0.035	-0.003	0.000	0.032	0.004	0.036	0.011	-0.077	-0.361	-0.216
5	Hartford, CT	0.039	-0.002	-0.001	0.036	0.000	0.036	0.011	-0.076	-0.356	-0.214
6	Boston, MA	0.035	-0.005	0.002	0.032	0.002	0.033	0.010	-0.072	-0.335	-0.201
7	Washington, DC	0.034	-0.003	0.000	0.031	0.002	0.033	0.010	-0.072	-0.333	-0.200
8	Philadelphia, PA	0.030	-0.001	-0.001	0.028	0.002	0.030	0.009	-0.064	-0.300	-0.180
9	Los Angeles, CA	0.033	-0.006	0.003	0.030	0.000	0.029	0.009	-0.063	-0.292	-0.175
10	Minneapolis, MN	0.023	-0.001	-0.001	0.021	0.007	0.028	0.008	-0.059	-0.276	-0.166
110	Jacksonville, FL	-0.019	0.001	0.000	-0.017	0.000	-0.017	-0.005	0.036	0.170	0.102
133	San Antonio, TX	-0.023	0.003	-0.001	-0.021	-0.001	-0.022	-0.007	0.048	0.223	0.134
147	Oklahoma City, OK	-0.032	0.003	0.000	-0.029	0.003	-0.026	-0.008	0.056	0.260	0.156
172	Norfolk, VA	-0.028	0.001	0.001	-0.026	-0.004	-0.030	-0.009	0.063	0.295	0.177
241	Joplin, MO	-0.066	0.006	-0.001	-0.060	-0.006	-0.066	-0.020	0.142	0.660	0.396
	Census Division										
1	Pacific	0.026	-0.006	0.003	0.023	0.000	0.023	0.007	-0.049	-0.228	-0.137
2	Middle Atlantic	0.021	-0.002	0.000	0.019	0.000	0.019	0.006	-0.040	-0.188	-0.113
3	New England	0.017	-0.003	0.001	0.015	0.000	0.015	0.005	-0.033	-0.155	-0.093
4	East North Central	0.001	0.001	-0.001	0.001	0.000	0.001	0.000	-0.001	-0.007	-0.004
5	South Atlantic	-0.008	0.001	0.000	-0.007	0.000	-0.007	-0.002	0.016	0.073	0.044
6	Mountain	-0.013	0.000	0.001	-0.012	0.000	-0.012	-0.004	0.026	0.121	0.073
7	West South Central	-0.019	0.003	-0.001	-0.017	0.000	-0.017	-0.005	0.036	0.167	0.100
8	West North Central	-0.029	0.004	-0.001	-0.026	0.000	-0.026	-0.008	0.056	0.263	0.158
9	East South Central	-0.030	0.005	-0.002	-0.027	0.000	-0.027	-0.008	0.058	0.269	0.161
	Metro Population										
1	Pop > 5 Million	0.041	-0.005	0.001	0.037	0.003	0.040	0.012	-0.086	-0.400	-0.240
2	Pop 1.5-4.9 Million	0.007	-0.001	0.000	0.007	0.002	0.008	0.003	-0.018	-0.083	-0.050
3	Pop 0.5-1.4 Million	-0.008	0.001	0.000	-0.007	0.000	-0.007	-0.002	0.015	0.068	0.041
4	Pop < 0.5 Million	-0.022	0.002	0.000	-0.020	-0.002	-0.022	-0.007	0.048	0.223	0.134
5	Non-Metro Areas	-0.036	0.004	-0.001	-0.033	-0.003	-0.036	-0.011	0.077	0.360	0.216
	US Standard Dev	0.034	0.004	0.002	0.031	0.004	0.033	0.010	0.071	0.332	0.199
	US Mean Abs Dev	0.029	0.004	0.002	0.026	0.003	0.028	0.009	0.061	0.283	0.170

TABLE 3: SIMULATED EFFECTS OF TAX DIFFERENTIALS ACROSS ALL AREAS FOR ALTERNATE CALIBRATIONS

	Benchmark case (1)	All land in home goods (2)	Smaller land share (3)	Larger employment response: Cobb-Doug (4)	Inelastic home-good demand (5)	Wage diffs two-thirds estimated size (6)	Housing deductions ignored (7)	Federal taxes only, no state taxes (8)	Adding Federal spending differences (9)
Economic Parameters									
Home goods share s_y	**0.360**	0.360	0.360	0.360	0.360	0.360	0.360	0.360	0.360
Traded good land share θ_L	**0.025**	**0.000**	**0.013**	0.025	0.025	0.025	0.025	0.025	0.025
Traded good labor share θ_N	**0.825**	0.850	0.825	0.825	0.825	0.825	0.825	0.825	0.825
Home good land share ϕ_L	**0.233**	**0.278**	**0.117**	0.233	0.233	0.233	0.233	0.233	0.233
Home good labor share ϕ_N	**0.617**	0.572	0.617	0.617	0.617	0.617	0.617	0.617	0.617
Comp. demand elast for home goods η	**-0.500**	-0.500	-0.500	-0.500	**0.000**	-0.500	-0.500	-0.500	-0.500
Elasticity of employment to tax/income ε	**-6.000**	-6.000	-6.000	**-9.370**	-6.000	-6.000	-6.000	-6.000	-6.000
Implied share of income to land s_R	**0.100**	0.100	**0.050**	0.100	0.100	0.100	0.100	0.100	0.100
Tax Parameters									
Marginal tax rate τ'	**0.361**	0.361	0.361	0.361	0.361	0.361	0.361	**0.333**	0.361
Deduction level δ	**0.293**	0.293	0.293	0.293	0.293	0.293	**0.000**	**0.257**	0.293
Average Percent Effects (Mean Abs Dev)									
Tax differential: $E\|d\tau/m\|$	**0.028**	0.028	0.028	0.028	**0.024**	**0.019**	**0.031**	**0.026**	**0.031**
Wage effect: $E\|dw\|$	**0.009**	**0.000**	0.009	0.009	0.007	0.006	0.009	0.008	0.010
Home-good price effect: $E\|dp\|$	**0.061**	**0.079**	0.061	0.060	0.052	0.040	0.067	0.056	0.067
Land rent effect: $E\|dr\|$	**0.283**	0.283	**0.567**	0.281	0.244	0.187	0.313	0.260	0.314
Employment effect: $E\|dN\|$	**0.170**	0.170	0.170	**0.266**	0.146	0.112	0.188	0.156	0.189
Deadweight Loss from Locational Inefficiency									
As a percent of income, E(DWL/Nm)	**0.33%**	0.33%	0.33%	**0.51%**	**0.24%**	**0.14%**	**0.40%**	**0.28%**	**0.41%**
Total DWL (Billions per year, 2008$)	**40**	40	40	62	29	17	49	34	49
Per Capita (per year, 2008$)	**133**	133	133	208	98	58	162	113	165

TABLE 4: DIFFERENTIAL FEDERAL SPENDING PATTERNS RELATIVE TO DIFFERENTIAL TAXATION PATTERNS, 2000

Type of Federal Spending	All Spending (1)	Wages and Contracts (2)	Non-Worker Benefits (3)	All Other Spending (4)
Panel A: Raw Differentials				
Federal Tax Differential	-0.094	0.281	-0.223	-0.019
(standard error)	(0.132)	(0.099)	(0.061)	(0.047)
Panel B: Adjusted Differentials				
Federal Tax Differential	-0.193	-0.072	-0.024	-0.075
(standard error)	(0.101)	(0.066)	(0.018)	(0.033)

Regressions weighted by population for all 290 observations.
Robust standard errors reported.

TABLE 5: DIFFERENTIAL TAX EFFECTS AND DEADWEIGHT LOSS FROM LOCATIONAL INEFFICIENCY AND HOME-GOOD OVERCONSUMPTION WITH DIFFERENT TAX REFORMS, 2000

	Existing System (0)	Eliminate Deduction No Change in Tax Rate (1)	Eliminate Deduction Equal Tax Decrease (2)	Increase Deduction Equal Tax Increase (3)	Index Tax to Wages No Ded Dec Tax (4)	Index Tax to COL No Ded, Dec Tax (5)	Index Tax to Wages Existing Deduct (6)	Index Tax to COL Existing Deduct (7)
Reformed Tax Parameters								
Marginal tax rate	0.392	0.392	0.350	0.491	0.350	0.350	0.392	0.392
Deduction level for cost of living	0.292	0.000	0.000	1.000	0.000	0.000	0.292	0.292
Deduction level for housing	0.740	0.000	0.000	1.000	0.000	0.000	0.740	0.740
Mean Abs Dev of Tax Diff: $E\|d\tau/m\|$	0.028	0.032	0.029	0.023	0.000	0.020	0.004	0.025
DWL as a Percent of Income								
from Locational Inefficiency	0.33%	0.42%	0.33%	0.21%	0.00%	0.18%	0.01%	0.29%
from Housing Overconsumption	0.30%	0.00%	0.00%	2.17%	0.00%	0.00%	0.30%	0.30%
Total	0.60%	0.42%	0.33%	2.17%	0.00%	0.18%	0.28%	0.56%

FIGURE 1: EFFECT OF FEDERAL TAXES ON A HIGH TRADE-PRODUCTIVITY CITY

In a simplified model ($r^j = p^j, Q^j = A_Y^j = 1$ for all j), replacing a lump-sum tax, T, with a utility-equivalent federal income tax, τ, raises wages, w, and lowers rents, r, and employment in Chicago, labeled "C," a city with high trade-productivity ($A_X^C > 1$), changing the equilibrium form E_0^C to E^C.

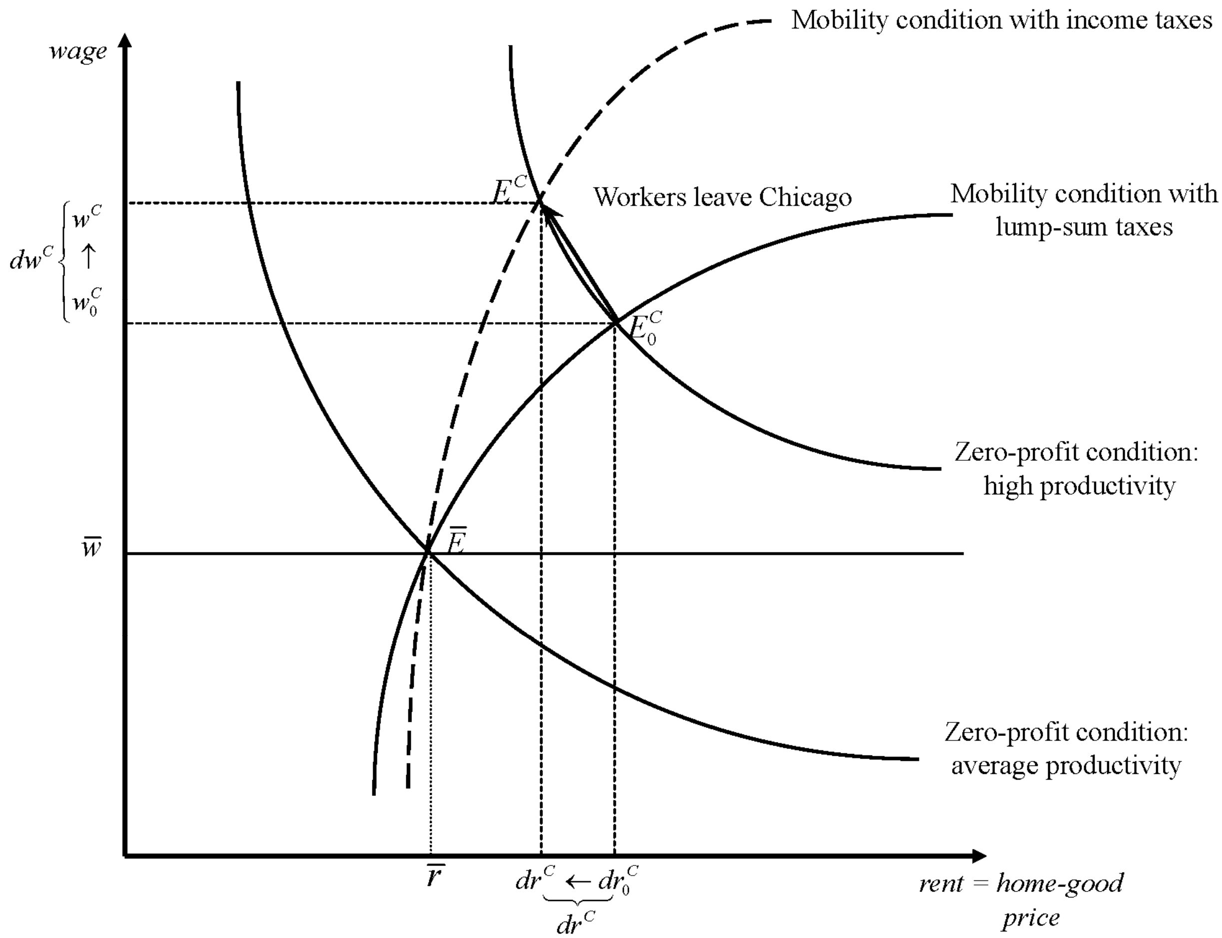

FIGURE 2: EFFECT OF FEDERAL TAXES ON A HIGH QUALITY OF LIFE CITY

In a simplified model ($r^j = p^j, A_X^j = A_Y^j = 1$ for all j), replacing a lump-sum tax, T, with a utility-equivalent federal income tax, τ, lowers wages, w, and raises rents, r, and employment in Miami, labeled "M," a city with high quality of life ($Q^M > 1$), changing the equilibrium form E_0^M to E^M.

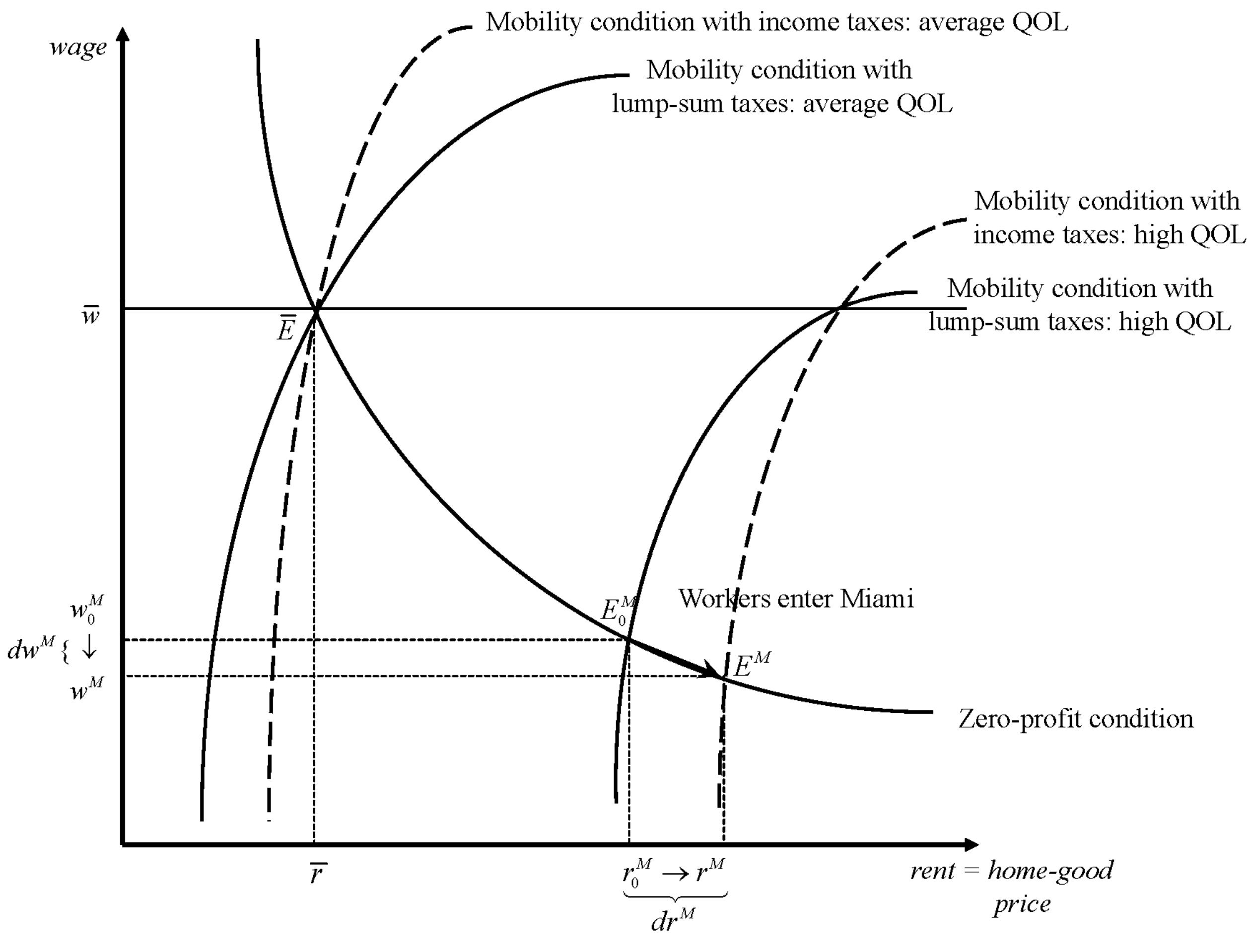

FIGURE 3: WAGE LEVELS AND HOUSING COSTS ACROSS AREAS, 2000

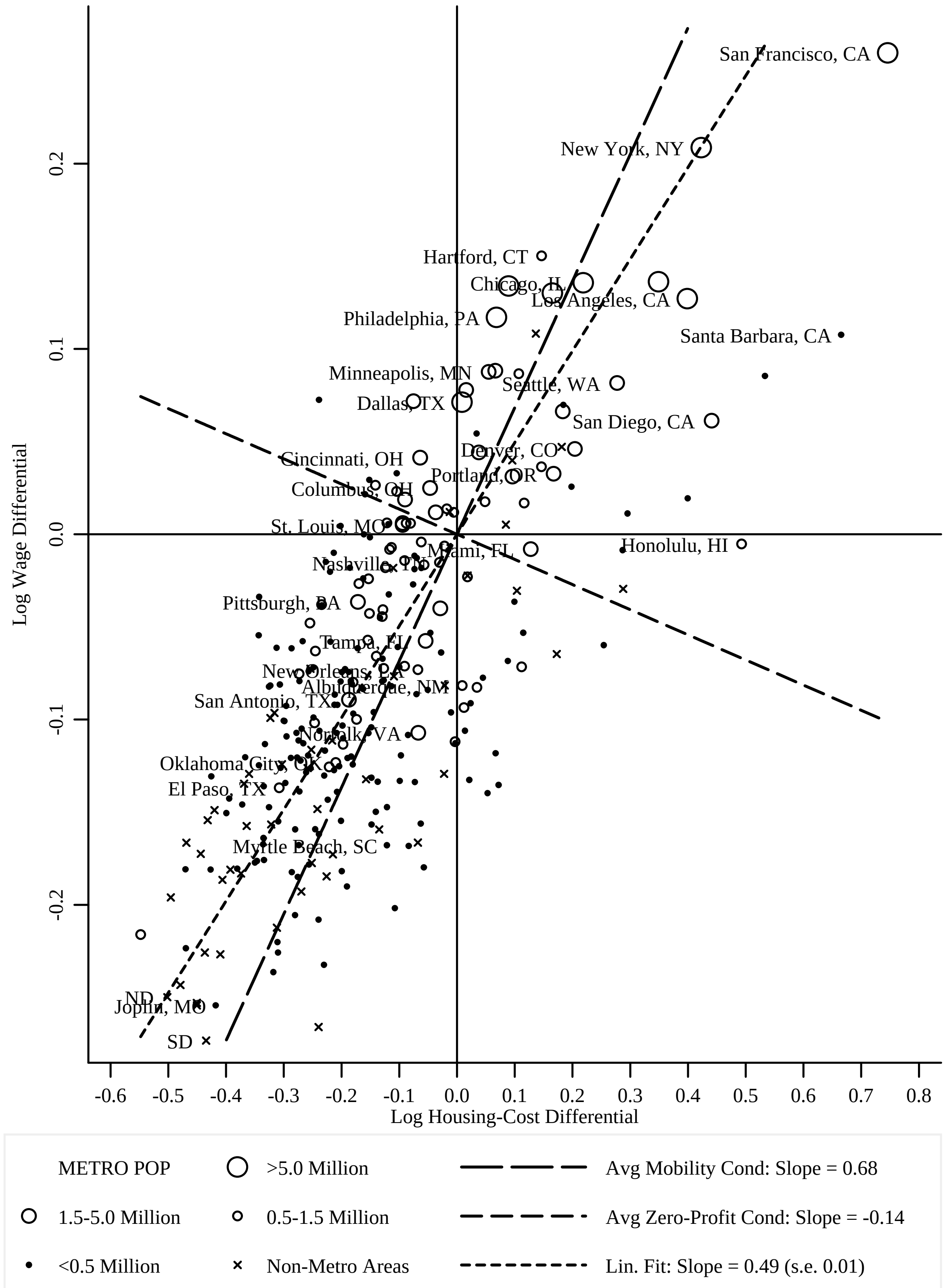

FIGURE 4: DIFFERENTIAL TAX BURDENS WITH AND WITHOUT DEDUCTION

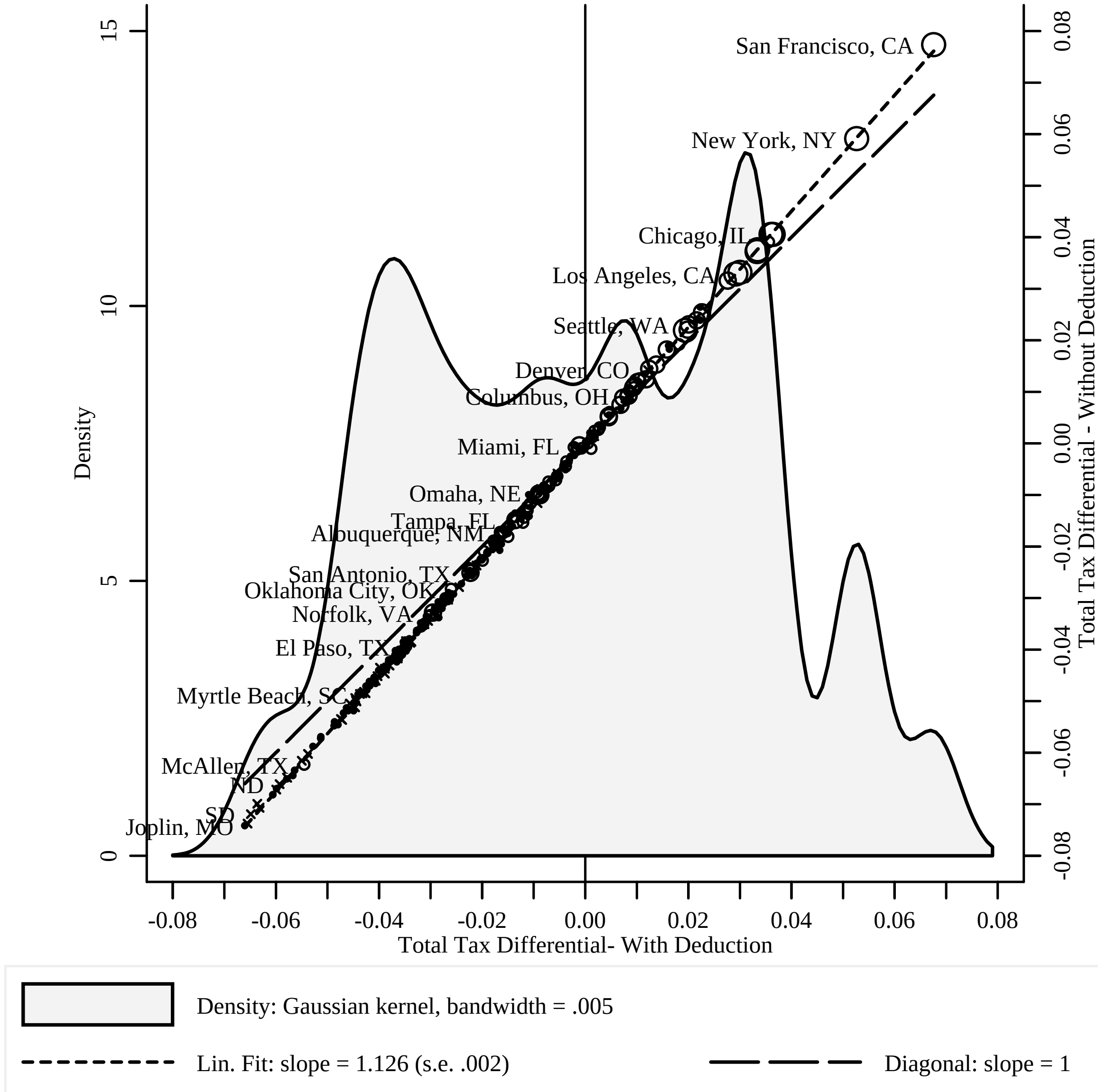

FIGURE 5: FEDERAL SPENDING AND TAX DIFFERENTIALS ACROSS AREAS