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State Tax Effects and Entrepreneurship
Estimates from a Border Model With Agglomeration Economies

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Abstract

We examine the impact of changes in cross-border differences in state tax conditions on the sorting of new business activity across state borders. A simple conceptual model yields a number of predictions that are tested using Dun and Bradstreet and other data from 2002 and 2005. GIS methods are used to code data into distance bands extending out from the border and to further divide the bands into segments along the border.

Findings indicate that an increase in taxes on one side of a state border prompts business activity to shift towards the opposite side. In lightly developed areas within one mile of the border the implied elasticity of the deterrent effect is between 15 and 24 percent. For the sales and corporate income taxes, these effects attenuate sharply with distance from the border and also with proximity to agglomerations of existing business activity. For the personal income tax, deterrent effects attenuate more slowly with distance and persist in agglomerated areas. Our model suggests that these differences arise because of differences in transport costs in addition to higher wages in urban areas. Further results confirm that increased weight on factor inputs in corporate tax apportionment formulas discourages business arrivals while reciprocal agreements governing personal income tax liabilities reduce deterrent effects. Core findings are also robust to measuring state tax conditions based on the Tax Foundation's State Business Tax Climate Index. Overall, our estimates help to explain the wide variety of tax-deterrent estimates obtained in previous studies and also suggest that policy makers should take seriously the deterrent effect of higher state taxes on business activity.

The avoidance of taxes is the only intellectual pursuit that carries any reward – John Maynard Keynes, Attributed, A Dictionary of Scientific Quotations (1977), Alan L. MacKay, p.140.

I. Introduction

There is truth in Benjamin Franklin's famous quote, "The only thing certain in life is death and taxes." But for local policy makers, the quote above from John Keynes demands more attention. That is because one way that entrepreneurs and households may seek to avoid taxation is by relocating to more tax advantaged locations. This idea was not lost on Tiebout (1956) and Hamilton (1976) in their seminal papers on the possibility that households may vote with their feet. It has also been the focus of numerous papers that have sought to measure the impact of local tax policy on business location decisions. A notable feature of those studies, however, is their lack of consensus as to whether local taxes discourage business, and the absence of a general structure that accounts for the mixed patterns of results.[1] This paper takes up this issue.

We argue that much of the ambiguity in the literature has arisen for two reasons. The first is that local tax conditions may be endogenous to the presence of local business activity. Studies differ in their approach to this issue and that likely contributes to differences in findings. The second is of a more conceptual nature. Prior studies have differed in the degree to which they controlled for three features of the local environment that affect the response of entrepreneurs to local tax policy. These are as follows.

First, increases in local taxes are likely to have a much stronger deterrent effect in lightly developed areas. This is because valuable natural amenities and agglomerations of existing businesses may attract new arrivals even in a high-tax environment. Second, increases in local taxes will likely have their greatest effects close to the border of a taxing jurisdiction because entrepreneurs would only have to travel a short distance across the border to enjoy a more favorable tax environment. This may help to

[1] Early literature on the impact of taxes on businesses location typically failed to find evidence of a notable deterrent effect, and in some cases even found that higher taxes "attract" businesses (Carlton (1979, 1983) and Schmenner (1978, 1982)). This began to change in the late 1980s and 1990s as studies by Bartik (1985, 1994), Papke (1991), Hines (1996), and others offered evidence that higher taxes do deter businesses. However, most of the estimates were noisy or small relative to the effect of other policies (see Wasylenko (1997) for a review).

explain why recent studies that have focused on the border region of a taxing jurisdiction tend to find larger tax effects. Third, we argue that it is important to control for *all* sources of a local government's revenue. That is because jurisdictions that rely less on one source of revenue will necessarily rely more on other revenue sources, and businesses are often sensitive to multiple forms of taxation (e.g. both income and sales taxes).

While various studies in the literature address at least one of the issues highlighted above, we are aware of none that take all into account. We do so in this paper in a series of empirical exercises that examine the impact of state tax conditions on new business arrivals. Our estimates are revealing of conditions that affect the impact of local tax measures on the entrepreneur's choice of where to locate a new business. Our findings also help to explain the variety of estimated tax effects found in the literature.

We begin with a simple conceptual model based on a closed city framework that does not allow for migration of businesses into or out of the border region. In that respect, our focus throughout the paper is on the *sorting* of businesses across the state border, but not on the level of economic activity in the border region. We show that sorting outcomes in the model are sensitive to the presence of a competing sector for land (e.g. residential), and also the presence of agglomerations of existing business activity. We show that this latter result can arise for two reasons: agglomeration economies are likely especially valuable to the business sector as opposed to the residential sector, and higher urban wages likely amplify the magnitude of the personal income tax relative to other sources of tax revenue (e.g. sales tax and corporate income tax). We also show that sorting outcomes are sensitive to transport costs that differ for shopping versus work-related trips, and also across industries. Further details of our model are outlined later in the paper. For now, it is sufficient to emphasize that our model yields five key results: (i) higher taxes on one side of a border tend to shift business activity towards the low tax side of the border, (ii) tax effects should be strongest in lightly developed areas, (iii) tax effects should attenuate as one moves into the interior of the state, (iv) tax effects should be less pronounced for industries for which transport costs are high relative to the price of the product or service provided, and (v) deterrent effects of the personal income tax should attenuate less rapidly with distance to the border and proximity to agglomerated locations as compared to that of sales or producer taxes. Further details on the development of each of these predictions are provided later in the paper. We test each in the empirical work to follow.

The core strategy for our empirical design is to rely on a border model approach in conjunction with multiple layers of differencing across and along the state border, and also over time. For the lower 48 state borders, GIS (geographic information system) software is used to create distance bands on both sides of the state border for distances of 0 to 1 mile, 1 to 5 miles, and 5 to 10 miles. These bands are then broken into short segments creating large numbers of polygons at different distances from and along each border. Opposite polygons on alternate sides of a state border and of the same distance to the border are referred to as "wedge-pairs" and each side of a wedge-pair is arbitrarily designated as side 1 or side 2. Existing employment and arrivals of new businesses by 2-digit SIC code are calculated for each polygon and wedge-pair using Dun and Bradstreet Marketplace data for the fourth quarters of 2002 and 2005.

Our dependent variable is measured as the side-2 share of business arrivals in the last twelve months associated with a given wedge-pair. This variable and our measures of cross-border differences in tax conditions are then differenced between the fourth quarters of 2005 and 2002. Separate regressions are run for wedge-pairs at different distances from the state border. Our models also allow for differences in the density of development across wedge-pairs in the base period (in a manner to be clarified).

We rely on two key assumptions for identification. The first is that *changes* in cross-border differences in state level tax conditions are exogenous to *changes* in side-2's share of new business arrivals for individual wedge-pairs along the state border. The second is that changes in cross-border differences in economic activity within a given wedge-pair are exogenous to changes in the difference in economic activity between the two states overall. The first assumption will be true as the size of the wedge-pairs becomes small reducing the influence any one wedge-pair might have on state policy. The second assumption must be true as the distance between the two sides of a wedge pair becomes small, ensuring that the two sides belong to the same local economy. Because our wedge-pairs are small relative to their respective states, and because the two sides of a wedge-pair are never more than ten miles apart, both identifying assumptions strike us as plausible.

Our double differencing approach both across the border and across time is in the same spirit as recent border studies by Holmes (1998) and Cunningham (2007). These studies considered the impact of state-level right-to-work laws and local land use regulation, respectively.[2] Other even more recent studies by Duranton, Gobillon, and Overman (2009) and Rathelot and Sillard (2008) have used border models to consider the effect of property taxes and local corporate income taxes, respectively.[3] We also build off of three recent papers by Devereux, Griffith, and Simpson (2007), Jofre-Monseny and Sole-Olle (2008), and Brulhart, Jametti, and Schmidheiny (2009). These papers have considered the possibility that agglomeration may mitigate the deterrent effects of business taxes and/or subsidies.[4] Devereux, Griffith, and Simpson (2007), for example, found that government subsidies have less impact on a firm's location decision in more highly developed areas. Our work is further motivated by recent studies in the agglomeration literature which show that activity within one mile matters much more to many entrepreneurs than just five miles away (e.g. Rosenthal and Strange (2003, 2005), Arzaghi and Henderson (2008)). Our modeling of the possible spatial attenuation of tax effects echoes this literature.

Throughout the paper our primary focus is on the influence of three sources of state tax revenue: corporate income taxes, personal income taxes, and sales taxes. We do this by first computing the share of revenue obtained from each of six sources of revenue that make up the state's *entire* budget. We then include these revenue sources in our regressions omitting the share of state revenue obtained from intergovernmental transfers to avoid perfect collinearity (since the revenue shares sum to one). Our

[2] Holmes (1998) was among the first to use border methods to analyze the impact of local of public policies. Comparing manufacturing activity just on either side of a state border, he found that states with right-to-work laws in place – which give workers the right to *not* join the union – enjoyed notably higher manufacturing employment growth since the 1940s. He also found that this effect attenuated rapidly as one moved away from the state border. We find analogous results for cross-state border differences in tax conditions, as will become apparent.
[3] Both Duranton, Gobillon, and Overman (2009) and Rathelot and Sillard (2008) instrument for local tax measures using local political variables such as the share of voters belonging to a more conservative political party. Both studies find that higher taxes negatively affect growth of existing businesses although Duranton et al (2009) do not find an effect on the creation of new businesses.
[4] See also Greenstone and Moretti (2004) and Greenstone, Hornbeck and Moretti (2010) for related work. These papers use a dissimilarity index to measure the *relative* difference across areas in the degree of agglomeration. While these papers make a valuable contribution, it is important to note that the dissimilarity index measures the *relative* concentration of activity in one area as compared to another, but not the *level* of activity in an area. Agglomeration, however, is fundamentally about the level of economic activity, and for that reason, we interact our cross-border tax measures with the *level* of agglomeration (measured as employment per square mile).

estimates, therefore, should be interpreted as the impact of a state's reliance on a given source of revenue *relative* to its reliance on intergovernmental transfers.[5]

We obtain two broad sets of results. The first concerns the role of agglomeration. For the sales and corporate income taxes, in lightly developed areas, entrepreneurs are notably more likely to locate their businesses on the low tax side of the border. In heavily developed areas, the influence of cross-border differences in taxes is greatly diminished. Moreover, failing to control for agglomeration tends to obscure the impact of sales and corporate income taxes which may contribute to the mixed findings in the previous literature. For the personal income tax, it is also true that deterrent effects diminish with proximity to agglomerations of existing business activity. In this instance, however, the rate of attenuation is considerably reduced and deterrent effects persist even in densely developed areas.

The second pattern pertains to the distance from the state border. We find compelling evidence that the impact of cross-border differences in state tax conditions attenuate sharply as one moves away from the state border. The attenuation of deterrent effects with distance echoes findings in the agglomeration literature that activity within one mile matters much more than just five miles away (e.g. Rosenthal and Strange (2003, 2005), Arzaghi and Henderson (2008)). We also find evidence that tax effects are least prevalent in the retail sector as compared to manufacturing, wholesale trade, finance/insurance, and services. The retail sector is known to have high transport/travel costs relative to the price of the product provided. Later in the paper, we argue that the combination of findings just noted is consistent with the idea that higher transport/travel costs reduce the impact of local taxes on business location decisions and cause tax effects to attenuate with distance from the border.[6]

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[5] We also control for state expenditures per capita. The intuition is straight forward: local residents and businesses may actually *benefit* from local taxation if their governments provide valuable services that could not be replicated in the private sector. Failing to control for local expenditures could therefore yield misleading assessments of the impact of different tax policies. See Oates and Schwab (1988) for related discussion.

[6] In contrast, we find that the influence of state expenditures per capita increases with distance from the state border. This likely arises because for businesses located close to the border entrepreneurs and their workers can easily commute from the state with their preferred expenditures. Further into the interior of the state employees are more likely to live in the state in which they work, increasing the importance of expenditure policies.

We also consider several extensions. For our first extension, we compare activity across states that differ in their corporate income tax apportionment formulas that are used to determine a multi-state firm's income tax liability in a given state. This issue has been the focus of recent work (see Goolsbee and Maydew (2000), Klassen and Shackelford (1998), and Gordon and Wilson (1986)). States weight corporate income for tax purposes based on the share of a firm's employment, property (e.g. plant and equipment), and sales that are found in a given state relative to the firm's activity level across all states. Each state independently sets its weights for the three components, creating variation across states in how corporate income tax burdens are calculated. Previous work has argued that higher weights on employment and property are equivalent to higher factor input taxes and create disincentives for business investment.[7] Consistent with that view, we find compelling evidence that businesses are attracted to states that put more weight on sales and less weight on investment in personnel and property. This is also consistent with anecdotal evidence that some states have shifted their apportionment formulas to place more weight on sales with the intent of attracting business. Importantly, the effect of apportionment formulas is also greatest in lightly developed areas close to the state border.

For our second extension, we examine the impact of a further feature of state tax systems that to our knowledge has received no previous attention in the literature. States differ in the degree to which they maintain reciprocal agreements that govern the state to which a worker pays state income tax in situations in which the worker lives in a different state from the place of employment. Reciprocal agreements stipulate that households pay income tax to the state in which the family resides. In the absence of such agreements, workers pay income tax to the state in which they work. With competitive labor markets, after-tax wages should be equal just on either side of a state border (all else equal). For that reason, when reciprocal agreements are not in force, businesses should have an incentive to locate on the low-income tax side of the state border to avoid having to compensate workers for higher personal income taxes. When such agreements are in force, business owners that locate close to the state border

[7] Estimates by Goolsbee and Maydew (2000) provide support for such behavior. See also a brief by the Institute on Taxation and Economic Policy (2008) for related discussion.

have little incentive to seek out the low tax side of the border because workers can commute from either state with no tax penalty. Our findings provide compelling support for this idea.

As a final robustness check we experiment with an alternative characterization of state tax conditions. We replace our revenue measures with the Tax Foundation's business tax index. That index is based on various state business tax rates and provisions and provides an *ordinal* measure of the degree to which different states have business-friendly tax environments. Findings from these models reinforce the results already described. In particular, more business friendly states attract entrepreneurial activity, but more so in lightly developed areas close to the state border.

Our estimates are of economic importance, but this also depends on the location considered and the type of tax. In lightly developed areas within one mile of a state border, doubling a state's reliance on the corporate income tax – holding constant the adjacent state's tax conditions – would reduce business arrivals by roughly 23.8 percent. That effect falls to just 14.1 percent for locations one to five miles from the border, and largely disappears for locations five to ten miles from the border. Cross-border differences in household income taxes and sales taxes have analogous effects, but are somewhat smaller in magnitude. All of these effects attenuate in urban areas filled with valuable agglomerations of existing establishments, but as noted above, the rate of attenuation is considerably faster for sales and corporate income taxes. Our results, therefore, help to explain the great diversity of findings in the literature: local taxes do affect business arrivals in lightly developed areas close to the jurisdiction's border, but these effects tend to attenuate as one moves away from the border and/or towards developed areas.

The following two sections present the conceptual and empirical models, respectively. Section 4 describes the data and summary measures. Section 5 presents the results, and Section 6 concludes.

II. Conceptual Model

2.1 Overview

This section provides a conceptual framework that highlights conditions under which differences in tax conditions across adjacent state borders affect the sorting of business activity to either side of the border. Our analysis is guided by a familiar and simple principle in public finance: tax burdens tend to be shifted towards those segments of a market that are most inelastic, whether on the supply or the demand side and allowing for interactions between product and factor markets. Absent government price controls and other sources of friction, tax equivalency arguments suggest that we can abstract from whether the statutory burden of the tax is levied directly on the producer – as with a corporate income tax – or the consumer – as with a sales tax. We begin with the simplest version of the model.

2.2 Fixed product price and wage

Suppose that there is only one bidder for land which we will refer to as the business sector, land markets are competitive, all firms are identical, and each firm produces one unit of output that is sold on the world market. Firms are price takers and sell their product for *P*. Output is produced using one unit of land and one unit of capital. All land is owned by absentee investors. We suppose also that there is an exogenous natural feature along the state border such as a river that makes land close to the state border particularly valuable to business establishments. This is not necessary but simplifies the exposition.

The firm's profit function is given by,

$$\pi(u) = P - \theta_1 u - rk - R(u) \tag{2.1}$$

where u is the distance to the border, r is the price of a unit of capital (k), and $R(u)$ is the cost of land at distance u. With competitive markets, profits are driven to zero and the firms' bid-rent is given by,

$$R(u) = P - \theta_1 u - rk \tag{2.2}$$

Suppose now that the state on side 1 of the border imposes a tax on firms equal to T per unit output. Maintaining the zero profit condition, the bid-rents on sides 1 and 2 of the border are given by,

$$R(u) = P - \theta_1 u - rk - \theta_2 T \tag{2.2a}$$

$$R(u) = P - \theta_1 u - rk \tag{2.2b}$$

In Figure 1, we display the bid-rents for land on either side of the state border before and after side 1 imposes its tax. With *T* set equal to zero, bid-rent is given by segment $\overline{bac}$, is symmetric with respect to the border, and declines with distance from the border. Following the imposition of the tax, however ($T > 0$), bid-rent on side 1 shifts down by an amount equal to the tax, and the bid-rent function is given by $\overline{edac}$. Implicitly, we assume that land is inelastically supplied to firms. Side-1 landowners therefore absorb the entire burden of the tax, and the equilibrium land rent function is given by $\overline{edac}$. Importantly, in this very simple model side-1 taxes do not affect the spatial distribution of business activity on either side of the border.

Suppose now that firms also require one unit of labor for each unit of output produced. Workers do not value proximity to the border amenity, but they do incur commuting costs which increase with distance. Wages are fixed at a common level, $\overline{w}$. With $T = 0$, each side of the border is again equally attractive to firms, and the spatial distribution of companies will be symmetric on either side of the border. It follows that residential bid-rent will also be symmetric on both sides of the border since proximity to employment opportunities u units distance from the border will be alike. Importantly, we assume that worker commuting costs rise more slowly with distance to employment as compared to the rate at which firm productivity spillovers decay with distance to the border amenity (e.g. the river). Given these assumptions, the residential bid-rent function is described by the darkened line in Figure 2, $\overline{gfh}$. With land going to the highest bidder, business activity will be found in the center, inside of the region defined by points p and n, while the residential districts will lie outside of those points.

Suppose once again that $T > 0$ causing the business bid-rent on side 1 to shift down. Holding constant the residential bid-rent, the equilibrium land rent function will shift to $\overline{gmdanh}$ with residential developers outbidding businesses for space over the region $\overline{qi}$. In this instance, establishments occupy the area along segment $\overline{ik}$, while the residential sector is on the periphery outside of points i and k.[8]

[8] Over time, the shift in business activity towards side 2 would cause the residential bid-rent function to shift down on side 1 and up on side 2 in response to changes in proximity to employment. Such shifts would tend to mitigate some of the movement of firms from side 1 to side 2. But as the change in the residential bid-rent will only occur if the spatial distribution of firms has shifted towards side 2, the core prediction of the model in Figure 2 remains: an increase in side-1 tax on business activity shifts the equilibrium concentration of firms towards side 2.

Summarizing, competition for space from the residential sector has three important effects: (i) it reduces the extent to which side-1 taxes are capitalized into lower equilibrium land rents, (ii) it reduces the relative share of business activity on side 1 by pushing business activity towards side 2 of the border, and (iii) the shift in side 1 business activity towards side 2 is greater further into the interior of side1 than close to the border. The first two predictions are intuitive. The third seems counterintuitive and is opposite from patterns noted in the Introduction. The next model addresses this issue.

2.3 Spatial variation in product shipping costs

The model described thus far assumed that all firms are exporters and sell their product in a world market at price *P*. For such firms we implicitly assume zero product shipping costs since a shift from side 1 to side 2 of a state border would not measurably affect the cost of shipping the product to distant markets. We now relax this assumption. To simplify the exposition, we also treat the tax as a sales tax although tax equivalency arguments noted above suggest that the discussion below applies for a producer tax as well (as with a corporate income tax). Personal income tax effects are treated separately in the following section where we also relax the assumption of fixed wages, $\overline{w}$.

To begin, as before all markets are assumed to be competitive. Customers therefore purchase from the firm that provides the product at the lowest price inclusive of shipping costs plus tax. The market area of a given firm is as illustrated in Figure 3. In the figure, suppose a firm is located at point *f* just on side 2 of the border. In the absence of any shipping costs, the total price to the consumer of purchasing from the firm located at point *f* is given by the heavy vertical line segment, $\overline{bf}$, which we denote as p_f. More generally, allowing for shipping costs the total price of buying from the firm at point *f* is given by the v-shaped dotted line, $\overline{abc}$, and increases with distance from *f*. Suppose now that side 1 imposes a tax of *T* per unit product as before. For side-1 firms located arbitrarily close to the border, the total price to the customer cannot exceed p_f given competition from side-2 firms at the border. Side-1 firms at the border must therefore reduce their price by an amount equal to the tax. As one moves into the interior of side 1, the degree to which the side-1 firm must drop its price begins to diminish subject to the constraint that the total price plus tax is just equal to the total price associated with purchases from the side-2 border firms inclusive of transport costs. Eventually, a point *d* is reached at which the shipping costs from the side-2 border firm just equal the side-1 tax. At this point, and for all points further into the side-1 interior, side-1 firms charge the same price for their product as in the absence of the tax.

Figure 4 illustrates the implications of the side-1 tax for the business sector bid-rent function. Beginning on side-2, we assume that business sector bid-rent declines with distance from the border as before, and is given by line segment $\overline{dj}$. Upon crossing the border into side 1, the business bid-rent drops discontinuously to point *c* by an amount equal to the side-1 tax. As one moves further into the interior of side 1, businesses charge higher prices as noted above, and this causes their bid-rents to increase. This continues until a location is reached at which firms charge the same price as would occur in the absence of the tax. At that location, and all areas further into the interior of side 1, the firm's bid-rent is the same as would arise in the absence of the tax, and declines towards point *a*.

If the business sector was the only sector competing for land, then as in Figure 1, landowners would fully absorb the burden of the tax and the tax would have no impact on the spatial distribution of business activity. But as before this is not the case in the presence of a competing sector for land. As drawn in Figure 4, the residential sector outbids the business sector for space between points *z* and *d* immediately adjacent to the border. Once again, side-1 taxes shift business activity towards side 2 of the border, but now that effect is most pronounced close to the border.

The model in Figures 3 and 4 has two further implications for differences in the sensitivity across industries to cross-border tax differentials. First, notice that as transport costs increase, the slope of the line segments associated with $\overline{abc}$ in Figure 3 also increase, reducing the distance between points *d* and *f*. This increases the slope of the bid-rent segment $\overline{bc}$ in Figure 4, narrowing the distance between *z* and *d* in that figure. That in turn reduces the size of the near-border area in which the tax displaces business activity on side 1. In effect, if travel/shipping costs are sufficiently high, side-1 firms face increasingly inelastic location-specific customer demand allowing them to push more of the burden of the tax onto consumers of the product or service. This reduces the tax effect on the business bid-rent function, and mitigates the impact of cross-border differences in taxes on business locations.

A second implication of Figures 3 and 4 is actually present in Figures 1 and 2 as well. As the value that firms place on proximity to the border attribute increases, that would increase the business bid-rent at any given location. In Figure 4, it is apparent that an upward shift in the business bid-rent would reduce the tendency for side-1 residential developers to outbid the business sector for land close to the border, thereby reducing the impact of the side-1 tax on business locations. From the agglomeration literature (e.g. Rosenthal and Strange (2004), Duranton and Puga (2004), and Glaeser and Gottlieb (2009)), we know that firms value proximity to existing concentrations of business activity. Thus, our model suggests that tax effects will be greater in lightly developed areas as compared to locations with dense concentrations of existing industry. This argument, however, depends implicitly on an important assumption: that the tax does not increase with the level of agglomeration. While this assumption may be credible, or at least approximately so, for the sales and corporate income tax, in the following section we argue that it likely does not work for the personal income tax. We turn now to that issue.

2.4 Personal income tax and spatial variation in wages

This section considers the impact of personal income taxes on the location decisions of border firms. Suppose that the tax is imposed on side-1 workers increases with their earned income regardless of whether they live on side 1 or side 2. In this instance, side-1 firms adjacent to the border would have to pay workers a wage equal to the previous wage $\overline{w}$ plus the tax, or $\overline{w}+T(\overline{w})$ where $\partial T(\overline{w})/\overline{w}>0$. Otherwise, workers would seek employment on side 2 of the border. This idea is illustrated in Figure 5.

In Figure 5, notice that as one considers business locations further into the interior of side 1, commuting costs to competing side-2 sources of employment would increase. This would mitigate the extent to which side-1 firms would increase worker wages to compensate for the tax. Eventually, a point would be reached at which side-1 nominal wages would settle back to their "no-tax" level and from that point further into the interior of side 1, wages would be unaffected by the tax. Analogous to the discussion associated with Figure 3, far enough into the interior of the state, labor supply faced by individual firms is sufficiently inelastic that employers can push the burden of the personal income tax onto workers. Absent further considerations, the qualitative impact of the personal income tax would be the same as that of a sales or producer tax, as in Figure 4. Three features of labor markets, however, are likely to affect the magnitude and nature of deterrent effects associated with the personal income tax, causing those effects to differ from that of a sales or producer tax.

The first difference concerns transport costs. As noted earlier, if transport costs are high relative to the value of the product or service traded, the slope of $\overline{bc}$ in Figure 4 should be steeper and the deterrent effects of taxes should attenuate more quickly with distance from the border. In the case of a labor tax, the cost of commuting relative to the value of a day's labor seems likely to be small in comparison to the cost of travel relative to the value of a shopping trip (as would affect the influence of a sales tax, for example). This flattens segment $\overline{bc}$ in Figure 4 and, for that reason, we expect the deterrent effect of the personal income tax to attenuate more slowly with distance from the border as compared to that of a sales tax or a corporate income tax.

The two remaining differences concern the size of the personal income tax in agglomerated areas. It is well documented that nominal wages are notably higher in urban areas (e.g. Glaeser and Mare (2001)). With a progressive state income tax system, this suggests that marginal personal income tax rates will tend to be higher in agglomerated areas. When combined with the higher wages, this further implies that the level of personal income tax paid by a given worker will tend to be higher in agglomerated areas. Consider further that workers seek alternate employment across a state border if the tax incentives outweigh the "relocation/location" costs. Such costs seem unlikely to vary systematically with urban size, or at least approximately so. Under such conditions, higher wages in urban areas have the indirect effect of increasing the effective size of the tax net of relocation/location costs. In Figure 4, this suggests that as agglomeration shifts up the firm's bid-rent function by increasing the height of point d, it also increases the size of the tax by increasing the length of segment $\overline{dc}$. These two effects potentially offset, reducing the degree to which tax-deterrent effects attenuate with agglomeration.[9]

2.5 Model predictions

Summarizing the discussion above, our model generates five key predictions that we will test. The first is that a tax increase on one side of a jurisdictional border will shift business activity towards the opposite side. The second is that tax effects will tend to be less pronounced when the border region is highly valued by firms, as when an agglomeration of existing business activity is present. The third is that tax effects will tend to attenuate as one moves into the interior of the jurisdiction, away from the border. The fourth is that tax effects will have a smaller impact on industries for which travel/shipping costs are large relative to the value of the product or service produced. The fifth is that relative to the influence of sales and corporate income taxes, the deterrent effect of the personal income tax is likely to attenuate more slowly with distance from the border and also with proximity to densely developed areas.

III. Empirical Model

3.1 Identification strategy

This section lays out the empirical model used to estimate the impact of cross-border differences in state tax conditions on the location of businesses close to the state border. Central to our identification strategy is the use of differencing methods designed to control for unobserved factors. The necessary assumptions for this approach to yield defensible estimates of tax effects are made explicit below. We begin with a model that only differences activity across the state border.

[9] An analogous offsetting effect is likely to be of a smaller magnitude for the sales and corporate income taxes given the manner in which those taxes are set and interact with local prices.

3.2 Differencing across the state border

The number of arrivals of new businesses (*N*) to a given side of a state border in period (year) *t* depends on two things. It depends on the total number of arrivals to the border region and it also depends on the allocation of those arrivals to each side of the border. In the model below, we eventually focus on the share of arrivals on side 2 of the state border, where sides 1 and 2 are specified randomly. We also break each state border into discrete, continuous segments, and measure business activity on either side of each segment in distance bands that are progressively further into the interior of the state (e.g. 0 to 1 mile, 1 to 5 miles, 5 to 10 miles). Two adjacent geographic wedges on opposite sides of a border are referred to below and throughout the rest of the paper as a "wedge-pair," and are indexed by the subscript *w*.

The *number* of arrivals to a given wedge-pair in period *t* are assumed to depend on state-level tax (*T*) and all other attributes (Ω) specific to a given wedge-pair, including both local and state-level attributes apart from *T*. Accordingly,

$$N_{1wt} = \theta_1^1 T_{1t}^{state} + \theta_2^1 T_{2t}^{state} + \theta_3^1 \Omega_{1wt} + \theta_4^1 \Omega_{2wt} \quad (3.1a)$$

$$N_{2wt} = \theta_1^2 T_{1t}^{state} + \theta_2^2 T_{2t}^{state} + \theta_3^2 \Omega_{1wt} + \theta_4^2 \Omega_{2wt} \quad (3.1b)$$

Summing these two expression to obtain the total number of arrivals to the border region in period *t* yields,

$$\begin{aligned} N_{wt} &\equiv N_{1wt} + N_{2wt} \\ &= (\theta_1^1 + \theta_1^2) T_{1t}^{state} + (\theta_2^1 + \theta_2^2) T_{2t}^{state} \\ &\qquad + (\theta_3^1 + \theta_3^2)\Omega_{1wt} + (\theta_4^1 + \theta_4^2)\Omega_{2wt} \end{aligned} \quad (3.2)$$

Because it is arbitrary as to which side of the state border is labeled side 1 versus side 2, symmetry implies that $\tilde{\theta} \equiv \theta_3^1 + \theta_3^2 = \theta_4^1 + \theta_4^2$. This says that the marginal effect of local attributes on side 1 of the border on total arrivals to the border region is the same as the marginal effect of local attributes on side 2. With regard to state-level tax conditions we impose a stronger assumption. Specifically, we assume that $\theta_1^1 = - \theta_1^2$ and $\theta_2^1 = - \theta_2^2$, or equivalently, that $\theta_1^1 + \theta_1^2 = \theta_2^1 + \theta_2^2 = 0$. Strictly interpreted, this would say that state tax conditions affect the allocation of arrivals to either side of the state border, but not the total number of arrivals in the border region. In practice, of course, state tax conditions would affect business arrivals throughout the entire state, including possibly the border region. However, because our focus is ultimately on the *relative* allocation of arrivals across the state border, we abstract from concerns about the aggregate level of arrivals. Implicit in this approach is the idea that local attributes (e.g. the level of agglomeration) associated with different wedge pairs drive the distribution of economic activity *along* a state border while cross-border differences in state tax conditions affect the distribution of activity to either side of a given wedge-pair.

Imposing $\tilde{\theta} \equiv \theta_3^1 + \theta_3^2 = \theta_4^1 + \theta_4^2$ and $\theta_1^1 + \theta_1^2 = \theta_2^1 + \theta_2^2 = 0$, expression (3.2) simplifies to,

$$N_{wt} = \tilde{\theta} \cdot \Omega_{wt} \tag{3.3}$$

where $\Omega_{wt} \equiv \Omega_{1wt} + \Omega_{2wt}$ and Ω_{wt} represents all attributes of the wedge-pair apart from state-level tax conditions.

We now consider the share of arrivals to side 2 of the wedge-pair in time *t*. This is obtained by dividing (3.1b) by (3.3). Denoting side 2's share of arrivals in period *t* as $n_{w,t}^2 \equiv \dfrac{N_{2wt}}{N_{1w,t} + N_{2w,t}}$, and defining $\theta_1 = abs(\theta_1^2)$, we obtain,

$$n_{w,t}^2 = \frac{\theta_1}{\tilde{\theta}} \cdot \frac{T_{2t}^{state} - T_{1t}^{state}}{\Omega_{wt}} + \frac{\theta_3^2}{\tilde{\theta}} \cdot \frac{\Omega_{1wt}}{\Omega_{wt}} + \frac{\theta_4^2}{\tilde{\theta}} \cdot \frac{\Omega_{2wt}}{\Omega_{wt}} \tag{3.4}$$

Adding $\dfrac{\theta_3^2}{\tilde{\theta}} \cdot \dfrac{\Omega_{2wt}}{\Omega_{wt}} - \dfrac{\theta_3^2}{\tilde{\theta}} \cdot \dfrac{\Omega_{2wt}}{\Omega_{wt}}$ to the right side of (3.4) and simplifying yields,

$$n_{w,t}^2 = \frac{\theta_1}{\tilde{\theta}} \cdot \frac{T_{2t}^{state} - T_{1t}^{state}}{\Omega_{wt}} + \frac{\theta_4^2 - \theta_3^2}{\tilde{\theta}} \cdot \frac{\Omega_{2wt}}{\Omega_{wt}} + \frac{\theta_3^2}{\tilde{\theta}} \tag{3.5}$$

Expression (3.5) says that the share of arrivals on side 2 of a wedge-pair in period *t* is sensitive to three components: (i) the cross-border difference in state tax conditions, $T_{2t}^{state} - T_{1t}^{state}$, interacted with the economic attributes of the wedge pair, Ω_{wt}, (ii) the economic attributes of side 2 of the wedge-pair interacted with the attributes of the wedge pair, Ω_{2wt}/Ω_{wt}, and (iii) a constant given by $\theta_3^2/\tilde{\theta}$. In principle, estimates of (3.5) would identify $\theta_1/\tilde{\theta}$ and the impact of cross-border differences in state tax conditions on the allocation of business arrivals to each side of the border. Estimating (3.5) is difficult, however, because of the need to measure Ω_{wt} and Ω_{2wt}/Ω_{wt}.

3.3 Differencing between time periods

Our solution to the measurement issues just noted is to difference (3.5) between the fourth quarter of 2005 and the fourth quarter of 2002, which we denote as periods *t* and *t-k*. Denoting $\Delta n_{w,t}^2$ as the change in side-2's share between *t* and *t-k*, we write,

$$\Delta n_{w,t}^2 \equiv \frac{N_{2wt}}{N_{1w,t}+N_{2w,t}} - \frac{N_{2w,t-k}}{N_{1w,t-k}+N_{2w,t-k}}$$

$$= \frac{\theta_1}{\tilde{\theta}} \cdot \left[\frac{T_{2,t}^{state} - T_{1,t}^{state}}{\Omega_{w,t}} - \frac{T_{2,t-k}^{state} - T_{1,t-k}^{state}}{\Omega_{w,t-k}} \right] + \frac{\theta_4^2 - \theta_3^2}{\tilde{\theta}} \cdot \left[\frac{\Omega_{2w,t}}{\Omega_{w,t}} - \frac{\Omega_{2w,t-k}}{\Omega_{w,t-k}} \right] \tag{3.6}$$

Note that the constant in (3.5) drops out of (3.6). In addition, two further assumptions greatly simplify the model. First, we assume that the two sample years are sufficiently close together that the relative attributes of a given side of a wedge-pair do not change. Hence, Ω_{2wt}/Ω_{wt} is treated as approximately time-invariant (at least over the sample horizon), causing the second bracketed term to drop out of the model. This strikes us as a credible assumption, although clearly an approximation. The second assumption is stronger. We assume that the economic attributes throughout a wedge-pair apart from the cross-border tax conditions are approximately time invariant. This implies that $\Omega_{w,t}$ is approximately equal to $\Omega_{w,t-k}$ which we write as Ω_w. Defining $a = \theta_1/\tilde{\theta}$, expression (3.6) then simplifies to,

$$\Delta n_{w,t,t-k}^2 = a \cdot \Delta(T_2^{state} - T_1^{state})_{t,t-k} \cdot \frac{1}{\Omega_w} \quad . \tag{3.7}$$

Expression (3.7) says that changes in side-2's share of business arrivals depends on changes in cross-border state tax conditions scaled by the economic environment associated with the wedge-pair, Ω_w. In the estimation to follow, we measure Ω_w using the given wedge-pair's employment density for the initial period, *t-k*.

It is also worth highlighting that identification of (3.7) requires that our right-hand side controls be exogenous. This is straight forward for Ω_w since we measure Ω_w using employment density throughout a given wedge pair – including activity from both sides of the border – and there is no reason why that density should be systematically related to side-2's share of business arrivals. As discussed in the Introduction, because our wedge-pairs are small in size, this suggests that they are "price takers" in the sense that changes in cross-border differences in state tax policy are exogenous to changes in side-2's share of new business arrivals. This helps to ensure that $\Delta(T_2^{state} - T_1^{state})_{t,t-k}$ is exogenous.

IV. Data and Summary Measures

4.1 Measuring cross-border differences in tax conditions

The model outlined above requires measures of the state-level tax conditions in each period, *t* and *t-k*. We address this need in two ways. In our first method, and for most of the estimation to follow, state tax measures are formed based on the state's *reliance* on a particular source of revenue. This is done by dividing the gross revenue from a particular source by the sum of all sources of revenue in the state. For these purposes, revenue sources include all forms of taxation (including licensing fees), as well as the change in the last year in the state's level of debt and the receipt of intergovernmental grants. Measuring revenue sources in this fashion facilitates taking the entire state budget into account in that revenue shares across sources always add to 1 for each state.

In our estimation models, we omit intergovernmental grants (primarily from the federal government to the states) to avoid perfect collinearity. Our estimates of tax effects, therefore, should be interpreted as *relative* to the influence of intergovernmental transfers.[10] Because entrepreneurs are likely to view intergovernmental transfers as unequivocally attractive, this makes intergovernmental transfers an intuitive and appealing reference category.

Measuring state tax conditions in this fashion has an obvious potential weakness. Revenue shares depend both on the statutory tax rates and also on the composition and level of economic activity. This raises the possibility that our tax shares could be endogenous. As noted in the Introduction, however, we rely on the border methodology and the small size of our wedge-pairs for identification. As the two sides of a wedge-pair become arbitrarily close, separated only by the state border, they must belong to a common local market except for the influence of cross-border differences in state policy. Because the two sides of our wedge-pairs are never more than ten miles apart, there is little reason to think that changes in side-2's share of new business arrivals would be systematically related to changes in cross-border differences in state-wide economic activity.[11]

As outlined in the Introduction, we also estimate our models using a second, very different measure of changes in cross-border differences in state tax policy. Specifically, we experiment with the Tax Foundation's business tax index measure. That measure is based on an agglomeration of many different features of the tax environment.[12] The measure is intended to characterize the degree to which state tax and regulation policies are welcoming of business activity. For that measure, we need only assume that the border area economies described by the wedge-pairs take state tax policy as exogenously given. As noted in the Introduction, this latter measure yields results that are consistent with the first approach to measure state tax conditions as will become apparent.

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[10] That category accounts for roughly 25 percent of state revenue, on average.

[11] If we instead included only tax rates themselves in the model, only the first identifying assumption would be necessary. This is implicitly the case for our alternative measure of tax conditions based on the Tax Foundation Index as described below.

[12] Specifically, the state business tax climate index is comprised of two equally weighted sub-indexes that measure the effect of the business tax rate structure and the business tax base, respectfully. The business tax rate sub-index is comprised of attributes of the corporate income tax structure such as the top tax rate, the number of brackets, and width of the brackets. Likewise, the business tax base sub-index measures how a state treats net operating losses and how a states deals with double taxation.

Data for state revenues and expenditures were obtained from the U.S. Census Bureau's website.[13] Data for the Tax Foundation business index were drawn from the Foundation's 2007 State Business Tax Climate Index (Dubay and Atkins, 2006).[14]

4.2 Creation of the "wedge-pairs"

The level of business activity (e.g. counts of companies, employment, etc.) is measured within different distance bands or buffers of state borders. This includes, 0 to 1 mile of the border, 1 to 5 miles, and 5 to 10 miles. The distance bands across the entire state boundary are further divided into smaller wedges of a given length (e.g. 20 miles). This creates "wedge pairs" along state borders, where the two sides of a given pair lie on opposite sides of the border. Figure 6 illustrates.

In the figure, the heavy black line denotes a state border. The dashed lines describe the edge of the buffer drawn on either side of the state border. The thin vertical lines create wedge pairs made up of two adjacent wedges, one on either side of the border. Creation of wedge pairs would be straight forward if all state borders were straight lines. However, this is not always the case. To allow for more complicated state borders that curve and even turn back on themselves, a modification of the approach above is used. Details on that approach are provided in Appendix A.

4.3 Dun and Bradstreet data

Establishment and employment data for the analysis were obtained from the Dun and Bradstreet (D&B) Marketplace files for the fourth quarters of 2002 and 2005. The data provide information on different types of establishments aggregated to the zipcode level. Using these data we are able to measure counts of establishments and their corresponding employment for different 2-digit SIC (Standard Industrial Classification) industries. The data also provide information on an establishment's number of years in service. This allows us to create counts of establishments and their employment for companies

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[13] See http://www.census.gov/govs/state/historical_data.html for links to the data.
[14] Current and past values of the Business Index can be found on the Tax Foundation's website at www.taxfoundation.org .

created in the previous 12 months. From those measures we compute the change in a given wedge-pair's side-2 share of new business arrivals which is used as the dependent variable as described earlier.[15] Also obtained from the data are year-2002 fourth quarter counts of total employment across all industries. Those measures are used to construct estimates of the density of employment in a given wedge-pair and are used to proxy for Ω_w in expression (3.7) as discussed in Section III.[16]

GIS software was used to code the zipcode level establishment data to the wedge pair geographic boundaries described above. To do this we first constructed correspondence weights that map zipcodes into wedge-pair polygons (see Appendix A for further details). Employment in a given wedge polygon is computed as a weighted sum of the employment drawn from those zipcodes that make up the polygon. For example, suppose that zipcodes 1 and 2 each have 100 and 200 businesses present, and also that side 1 of a given wedge-pair is comprised of 30 percent of zipcode 1 and 50 percent of zipcode 2. Then we would assign 30 + 100 workers to side 1 of the target wedge-pair.

4.4 Summary statistics

Table 1 reports the average share of state revenue obtained from the various revenue sources considered in the analysis to follow: corporate income tax, personal income tax, sales tax, intergovernmental funding, debt financing, and other miscellaneous revenue sources.[17] The reported values are calculated by averaging the respective revenue shares across all 48 states in the continental U.S.[18] An analogous measure is also provided for state government expenditures per capita. Separate values are reported for each year from 1993 to 2007.

[15] We also measured the employment associated with new business arrivals and used the change in side-2's share of such employment as the dependent variable. Results were nearly identical to those obtained when using side-2's share of business arrivals as the dependent variable and are not presented for that reason.
[16] We use the density of employment rather than employment counts for reasons outlined in Appendix A.
[17] Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.
[18] Some states do not have certain types of taxes, such as Tennessee which does not have a state income tax. In addition, the data does not contain information on the District of Columbia. As a result, the borders with the District are not included in the analysis.

Several patterns in Table 1 are important. First, although revenue shares vary over time, mostly they are quite stable. Intergovernmental funding (e.g. primarily transfers from the Federal government) typically accounts for about 22 percent of state revenues. Recall that this is the reference category that is omitted in the upcoming regressions to avoid perfect collinearity.

Sales tax and household income tax revenues both accounted for roughly 11 percent of state revenues in the last several years, while corporate income tax revenue accounted for only about 2 percent of state revenue, on average. These differences in magnitude will prove important when interpreting the magnitude of the estimated coefficients to follow. The same is true for debt financing which typically accounts for between 6 to 8 percent of state revenues.

Miscellaneous revenue sources are the largest single category, accounting for roughly 45 percent of state revenue. This category includes various types of user fees, licensing fees, fines, and lottery revenues. It also includes revenue from various state-owned entities. Such entities include utility companies and for some states, liquor stores. Also included in this category is insurance trust revenue which reflects discretionary contributions of government employees to government retirement and social insurance programs.[19] In the regressions to follow we control for miscellaneous sources of state revenue but focus discussion on the three primary sources of tax revenue, corporate income tax, personal income tax, and sales tax. Those three categories accounted for roughly 25 percent of state revenue in 2007 and are the primary focus of many policy debates and research when considering the impact of state taxes on local business activity.

Table 2 reports the mean, median, and standard deviation of the change in side-2 shares of arrivals for wedge-pairs at different distances from the state borders, and based on the two time periods noted earlier, the fourth quarters of 2005 and 2002. The reported values are based on roughly 22,000 wedge-pairs spread along 121 adjacent state pair-wise comparisons. Because side 2 of a border is assigned arbitrarily, one would expect that the mean and mean change in side-2's share of arrivals would

[19] For a more detailed description of the different categories of state revenue see the National Conference of State Legislature's report on "Taxes and State Revenue" at http://www.ncsl.org/default.aspx?tabid=17151.

be close to zero. This is indeed the case. Of more import is that the standard deviation in the share of arrivals is roughly 0.53 for each distance band (of 0 up to 1 mile, 1 up to 5 mile, and 5 up to 10 miles). The range in possible values of the change in side-2's share of arrivals varies from -1 to 1 given that the share of arrivals is between 0 and 1 and we then difference the share of arrivals between the two periods. The standard deviation is, therefore, relatively large in comparison to the possible range of the dependent variable. Such variation is necessary if we are to identify the influence of changes in cross-border tax conditions on changes in cross-border differences in the share of business arrivals.

Table 3 reports summary measures for our remaining key control variable, employment density in a given wedge-pair. Recall that this variable is used to proxy for Ω_w in expression (3.7). The table provides the distribution of values for this variable, from the 5th percentile up to the 95th percentile, in addition to the mean and standard deviation. Each row in the table corresponds to a different distance band as before. Panel A provides summary measures for the full sample of wedge-pairs included in the analysis, while Panel B provides summary measures for just those wedge-pairs located in census designated urban areas. Density is higher on average in Panel B as would be expected.

Focus now on the full sample in Panel A, which encompasses the entire length of all of the state-pair borders. As would also be expected, there is considerable variation in the density of development along state borders, ranging from just 1 worker per square mile at the 5th percentile up to 202.6 workers per square mile at the 95th percentile. Note also that for most locations the average employment density for any given part of the overall distribution (e.g. the 5th percentile versus the 95th percentile) is very similar across the different distance bands. The primary exception is at the upper end of the distribution. For the 95th percentile, for example, density is higher close to the border: 202.6 workers per square mile within one mile of the border, versus 166.9 workers per square mile between 1 and 5 miles of the border and 119.7 workers be square mile between 5 and 10 miles of the border. That pattern is also mirrored in the means (79.4, 57.8, and 56.7, respectively).

The greater importance of proximity to the state border in densely developed areas is suggestive that in such locations the state border is adjacent to a natural feature that either was at one time highly valued or is still highly valued today. St. Louis, which is on the Mississippi River and the border of Missouri and Illinois, is an example of the latter. Bleakley and Lin (2010) argue that Columbus and Augusta Georgia are both examples of the former, and at one time served as key points point along canoe portage paths that have since become obsolete.

V. Results

5.1 Tax effects without controls for agglomeration

Table 4 presents estimates from our simplest specification, excluding controls for agglomeration of business activity and also any special features of state policy (i.e. apportionment formula and reciprocal agreements). Each column in the table corresponds to activity at a different distance from the state border, including: 0 up to 1 mile, 1 mile up to 5 miles, 5 miles up to 10 miles, and in the far right column, 0 up to 10 miles.[20] T-ratios in parentheses are based on robust standard errors.[21] Recall also that we omit revenue shares obtained from intergovernmental transfers to avoid perfect collinearity. All of the revenue share coefficients, therefore, should be interpreted relative to the influence of intergovernmental transfers.

A quick review of the various coefficients in Table 4 reveals a striking pattern of results. Ignore for the moment the coefficients on the household income tax. Of the remaining coefficients in the model, many are of the wrong sign (as with the positive coefficients on corporate income tax revenue), and none have much power to explain changes in side-2's share of new business arrivals. In most instances, the t-

[20] All models include 2-digit SIC code fixed effects although further tests indicate that such fixed effects have no effect. In part, this is a check on the double differencing procedure which should serve to difference away time-invariant fixed effects.

[21] We also estimated the models in Table 4 and all of the following tables using standard errors clustered by state border pairs. That notably increased the standard errors and decreased the corresponding t-ratios. We favor the robust standard errors however, for two related reasons. That approach is more general, and we have no particular reason to believe that the error terms associated with adjacent cross-border wedges at one end of a state (e.g. the Nebraska-Kansas border) are meaningfully correlated with the error terms associated with cross-border wedges in distant locations at an alternated location along the border.

ratios on the individual coefficients are well below 1 in absolute value, and never above 1.5 (in absolute value). We also see little evidence that state expenditures per capita have any influence. This absence of a systematic relationship between changes in cross-border tax conditions and the arrival of new business activity is evident in each of the distance bands. Taken at face value, these results are reminiscent of early tax studies that failed to find evidence of a deterrent effect of local taxes. There are two caveats to that characterization, however. First, observe that the coefficients on the household income tax are negative and significant within five miles of the border, consistent with a deterrent effect. Second, the models in Table 4 depart from the specification implied by the theory in Section II and the specification in expression (3.7) in that they omit any controls for the level of agglomeration. We consider these issues further in the following tables.

5.2 With controls for agglomeration

Table 5 extends the analysis displayed in Table 4 by interacting each of the control measures with the log of employment density in a given wedge-pair. A quick review of this table yields a further set of striking results that reinforces some of the conclusions from Table 4 while challenging other patterns. For all of the major tax revenue measures, it is apparent that the non-interacted tax variables have negative, and mostly significant (sometimes highly so) effects on side-2's share of arrivals. This suggests that in lightly developed areas for which employment density is just 1 worker per square mile (causing its log to be zero), higher taxes discourage arrivals. In contrast, the interaction terms are all of opposite signs (positive). For the corporate income tax and sales tax those interaction terms are highly significant for locations within five miles of the border. Importantly, this confirms that the deterrent effects of these taxes diminish as one moves towards a more densely developed segment of the border. That finding is consistent with core predictions of the model outlined earlier. In conjunction with the patterns in Table 4, these findings also help to explain why many studies have failed to find evidence that local taxes discourage business activity – effects tend to be strongest in lightly developed areas but weaker in agglomerated locations.

A close read of Table 5a indicates that the pattern just noted only partly carries over to the household income tax. Consistent with estimates from Table 4, notice that although the interaction terms for the household income tax are positive (within five miles of the border), the corresponding t-ratios are well below one. Moreover, the point estimates of the coefficients on the non-interacted household income tax measure are similar to those in Table 4. These findings suggest that the deterrent effect of the personal income tax persists even in high-density areas. As suggested earlier in the paper, a possible explanation for this result is that higher urban wages amplify the size of the personal income tax, and especially relative to the state corporate income tax and state sales tax.

A further pattern in Table 5a lends additional support for the conceptual model outlined earlier. Notice that the model coefficients are typically larger and have much larger t-ratios for distance bands closer to the state border. As an example, the non-interacted coefficients on corporate income tax are -5 (with a t-ratio of -3.69), -2.9 (with a t-ratio of -2.32), and positive 2.27 (with a t-ratio of 1.22) for the 0 to 1 mile band, 1 to 5 mile band, and 5 to 10 mile band, respectively. A similar pattern of attenuation of tax effects with distance from the border is evident for the other tax revenue measures as well. To the extent that prior studies differed in their treatment of geography relative to a taxing jurisdiction's border, that likely also has contributed to differences in findings. In particular, the patterns in Table 5a suggest that border studies such as this one (and Duranton, Gobillon and Overman (2009)) are likely to find large effects of variation in local tax policy.

5.3 Magnitudes

The coefficients on the tax measures in Table 5a indicate the impact of a 1 percentage point change in the cross-border difference in tax revenue on the change in side-2's share of business arrivals. Focusing on lightly developed areas (the non-interacted coefficients), within one mile of the border (the first column), this suggests that a 1 percentage point increase in state 2's reliance on the corporate income tax would result in a 5 percentage point decrease in side-2's share of new business arrivals. This is a very large effect, and much larger than for the household income tax and the sales tax. For those sources of revenue, a corresponding 1 percentage point increase in reliance on the target revenue source would each reduce side-2's share of new business arrivals by only roughly 0.7 percentage points.

Although the magnitudes just described are "correct", they do not do justice to the sharp differences in reliance on different revenue sources as outlined in Table 1. Moreover, such differences are driven both by differences in the underlying tax rates (e.g. between the corporate versus the personal income tax) in addition to differences in the number of market participants (e.g. the number of corporations versus the number of individuals). Table 5b addresses this issue by presenting implied, approximate elasticities of the change in side-2's share of new business arrivals with respect to a doubling of side-2's reliance on a given revenue source. Holding constant the number of participants in a market, this exercise allows us to assess the magnitude of a change in the underlying tax rates on the distribution of new business arrivals across the state border. To allow for the influence of agglomeration on tax effects we present two measures for each of the model controls. The first is the implied elasticity in undeveloped areas (for which there is 1 worker per square mile). The second is the difference in the implied elasticities for undeveloped areas versus areas for which employment density is at the 75th percentile among the sample of wedge-pairs. In all cases, the t-ratios reported in parentheses are those for the raw coefficients in Table 5a.

Consider first the implied elasticities for undeveloped areas within 1 mile of the state border. For the corporate income tax, the implied elasticity is -23.8 percent. For the household income tax and the sales tax, the corresponding implied elasticities are -15.97 percent and -16.18 percent, respectively. Although the point estimate of the deterrent effect of the corporate income tax is somewhat higher than for the other two sources of tax revenue, overall the three have very similar magnitude effects. The rough equivalency of the three sources of taxation is consistent with what would be anticipated to the extent that suppliers and demanders in the product and factor markets respond to a given tax so as to push the effective burden of the tax onto the least elastic participant in the market, regardless of who has statutory responsibility for paying the tax. In contrast, the implied elasticity with respect to debt financing is smaller, just -2.72 percent, and is not significant (the t-ratio is -1.09). This latter result is suggestive that debt financing may be perceived as pushing taxes into the future which, with discounting, could account for the reduced deterrent effect relative to current taxes.[22]

As was evident from the interaction terms in Table 5a, it is also apparent in Table 5b that taxes other than the household income tax have a far lesser impact in densely developed areas. This is evident from the percentage point difference in the implied elasticities associated with 75th percentile density locations versus lightly developed areas. For the tax measures, those differences are always positive – implying a lesser deterrent effect in densely developed areas – and except for the household income tax, large enough in magnitude to eliminate any deterrent effect from taxation.

Consider next the top row in the table, corresponding to corporate tax effects in lightly developed areas. Reading from left to right across the columns, notice that the implied elasticity falls in magnitude from 23.82 percent within one mile of the border, to 14.11 percent 1 to 5 miles of the border, and actually flips to positive sign and is insignificant for activity 5 to 10 miles from the border. Analogous attenuation patterns are evident for personal income tax and sales tax effects as well. Overall, these patterns reinforce those of Table 5a and are consistent with patterns predicted by the conceptual model outlined earlier: they suggest that deterrent effects arising from cross-border differences in tax conditions attenuate rather quickly with distance from the border.

In contrast, further down the table notice that the elasticity measures for state expenditures per capita *increase* in magnitude to a more positive value as one moves further into the interior, from essentially zero within one mile of the state border up to an elasticity of 1 in areas 5 to 10 miles inside of the border. To the extent that most state expenditures target households and not firms, these patterns are consistent with the idea that close to the border entrepreneurs and workers can easily commute from the state with the preferred expenditure policies. For locations further into the interior of the state, however,

[22] Note also that miscellaneous sources of state revenue as defined earlier have an implied elasticity of -42.21 percent, with a t-ratio of -2.89 percent. Although the larger point estimate is suggestive of a larger magnitude effect, the underlying standard error is large enough to make uncertain as to whether miscellaneous sources of state revenue really have a larger impact than other sources of tax revenue.

business owners and workers tend to live in the state in which they work, and expenditure policies will take on greater importance.

5.4 Extensions

This section considers several extensions of our model that allow us to examine the robustness of our primary results. We begin with two additional features of state tax policy that affect the administration and calculation of corporate and personal income tax liabilities. As described in the Introduction, states determine how much a multi-state firm owes in corporate income tax based on a three factor weighting formula, where the factors are the company's in-state investment in employment (wage bill), property (based on the value of land, plant and equipment), and sales. Although many states apply equal weight to all three factors, previous work by Goolsbee and Maydew (2000) shows that increased weight on employment and property acts as a tax on factor inputs and discourages companies from locating their production and other facilities in the taxing state. For that reason, in the 1990s several states modified their apportionment formulas by increasing the weight placed on sales while maintaining equal weight on employment and property. There were no changes in state apportionment formulas during our sample period.

A second feature of tax policy that has received almost no attention in previous work are reciprocal agreements between adjacent states that govern the state to which an individual owes personal income tax. In the absence of a reciprocal agreement, workers pay income tax in the state in which they work. With a reciprocal agreement in place between two states, workers pay tax to the state in which they live. The set of reciprocal agreements in place during our sample period were all enacted many years prior to 2002. With competitive labor markets, in the absence of a reciprocal agreement, businesses have an incentive to locate on the low-income tax side of the border in order to avoid having to compensate their workers for higher personal income taxes through higher wages. But if a reciprocal agreement is in place, workers can live and pay tax in the low tax state even while working in the adjacent state. Under such circumstances, cross-border differences in personal income tax rates should have little impact on location patterns of businesses close to the border.

To take apportionment formula weights and reciprocal income tax agreements into account, we re-estimate the models in Table 5a but add two sets of additional variables. The first set are interactions between the corporate income tax variables and the 2002 cross-border difference in the weight placed on sales in the apportionment formulas. The second set are interactions between the personal income tax variables with a dummy variable that equals 1 if a reciprocal agreement was present in 2002 between the two adjacent states. Table 6 displays the results with the coefficients on all variables other than those pertaining to the corporate income tax and personal income tax suppressed. The complete model results from Table 6 are presented in Appendix B in Table B-2.

We consider first the influence of apportionment formulas and reciprocal agreements in lightly developed areas within one mile of the state border. As in Table 5, the non-interacted coefficients are negative and highly significant. Observe also that the interactions with the sales share in the apportionment formula (for the corporate income tax variable) and the reciprocal agreement dummy (for the personal income tax variable) are of opposite signs from their respective non-interacted terms and highly significant. For the corporate income tax terms, the pattern indicates that the deterrent effect of the corporate income tax is reduced when states increase the weight placed on sales in the apportionment formula. This is consistent with Goolsbee and Maydew (2000). New to the literature, the personal income tax results provide clear evidence that the deterrent effect of higher personal income taxes is essentially nullified by the presence of a reciprocal agreement. This is consistent with the conceptual model in section 2.4 which was based implicitly on the assumption that workers pay tax to the state in which they work. A close read of the patterns in Table 6 further indicates that the effects of the apportionment formula and reciprocal agreement are most pronounced in lightly developed locations close to the state border. This reinforces earlier results and further suggests.

Table 7 further extends the analysis by stratifying the regressions by 1-digit industry categories, including manufacturing, wholesale trade, retail, finance and insurance, and services. The model specifications are as for Table 6 except that we restrict our focus only to areas within one mile of the state border since that appears to be where the bulk of the tax effects are found. In addition, to more clearly highlight the main differences across industries we only report those coefficients that are non-interacted (full model results are in Table B-3 of Appendix B). Those coefficients pertain to lightly developed locations for which the two adjacent states have the same apportionment weighting formula and for which no reciprocal agreement is in place. For reasons outlined above, such locations are where tax effects are likely to be most pronounced.

Recall from the conceptual model in Section II that industries should be less sensitive to cross-border differences in state taxes when transport/travel costs are high relative to the value of the product or service produced. With that in mind, it is noteworthy in Table 7 that retail stands out as the industry whose locations patterns are least affected by local variation in tax conditions. The typical shopper purchases relatively few items on a given shopping trip, and that greatly increases travel costs per item purchased. Manufacturing and wholesale trade, in contrast, are industries for which products tend to be shipped in bulk, and that greatly reduces per unit shipping expenses. Similarly, finance/insurance and services tend to be high-valued items (although there are certainly exceptions) and that also tends to reduce travel costs relative to the value of the item traded. In conjunction with the attenuation patterns displayed in Table 5a, these patterns further reinforce arguments developed in Section II that transport costs will affect the rate at which tax effects to attenuate with distance from the state border, with high transport costs resulting in more rapid attenuation.

5.5 Tax Foundation Business Index

As a final exercise we consider a very different measure of local tax conditions. Specifically, we replace all of our revenue measures with a single index, the Tax Foundation's State Business Tax Climate Index (SBTCI). As noted in the Introduction, that index is based on a variety of business tax rates and related measures and is designed to inform policymakers and others about current state tax policy that impacts a state's relative competiveness in attracting and maintaining businesses. The index varies between 0 and 10 taking on non-integer values with higher numbers indicating a more business-friendly environment. Index values are displayed in Table B-4 of Appendix B for all fifty states for both 2003 and 2006. To facilitate comparison to our previous tables we multiplied the index by -1 to reverse its sign. A negative coefficient on the transformed index is therefore indicative of a deterrent effect. The log of state expenditures per capita is also included in the model along with industry fixed effects as before.

Table 8 displays the results. Notice that the non-interacted tax index coefficients are negative and significant for all distance bands, while the interactions with the local density of development always have a positive coefficient. Notice also that the tax coefficients decrease in magnitude with distance from the border while the expenditure coefficients, which are positive, increase in value. These patterns are the same as in our previous tables. This reinforces our core finding that state tax effects have a greater impact in lightly developed areas close to the state border, and especially for business-related taxes.

VI. Conclusions

This paper has revisited an old question that has eluded efforts to provide a stable and clear answer: we examine the deterrent effect of local taxes on business activity with a particular focus on the sorting of businesses across state borders. Most important, we show that an increase in state-level taxes on one side of a state border prompts business activity to shift towards the opposite side of the border. Within one mile of the border, the implied elasticity of the tax-deterrent effect is between 15 and 24 percent. However, these effects attenuate sharply with distance from the border.

A second general and important result concerns the role of agglomeration. For the corporate income tax and sale tax evidence indicates that tax-deterrent effects attenuate sharply with the local density of business activity. This suggests that the allure of agglomeration economies may well allow cities to attract entrepreneurs even in the face of higher sales and corporate taxes. On the other hand, for the personal income tax, deterrent effects largely persist in urban areas, consistent with the possibility that higher urban wages amplify the deterrent effect of the personal income tax.

Additional findings indicate that tax-deterrent effects are most pronounced for industries for which transport costs are low relative to the value of the product/service provided. Increased weight on factor inputs in corporate tax apportionment formulas is also found to discourage business arrivals while reciprocal agreements governing personal income tax liabilities reduce deterrent effects. The former result on apportionment formulas supports previous findings by Goolsbee and Maydew (2000), while the latter result on reciprocal agreements is entirely new to the literature. Our core findings are also robust to an alternate measure of state tax conditions based on the Tax Foundation's State Business Tax Climate Index.

Overall, our model and estimates offer a systematic structure that helps to explain the wide variety of tax-deterrent estimates obtained in previous studies. Our findings also suggest that state lawmakers should take seriously the possibility that differences in tax conditions relative to adjacent states will affect their economies. This is especially true for border communities in lightly developed areas. It is also especially true for the personal income tax regardless of the local density of development.

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Figure 1: Single Sector and No Transport Costs

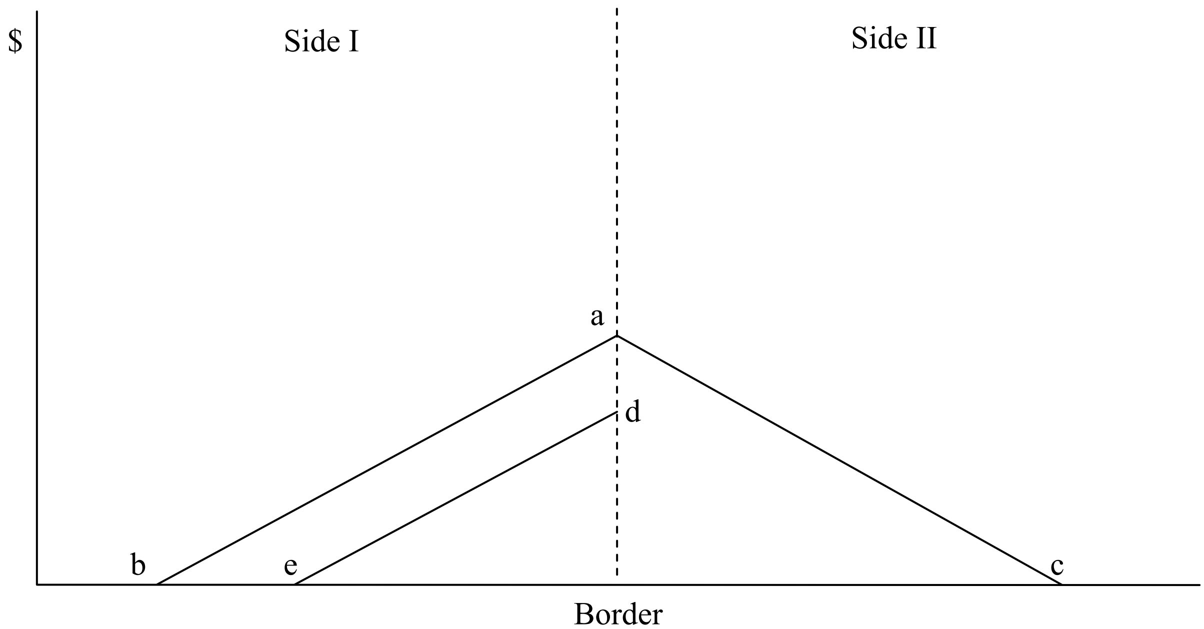


Figure 2: Two Sectors and No Transport Costs

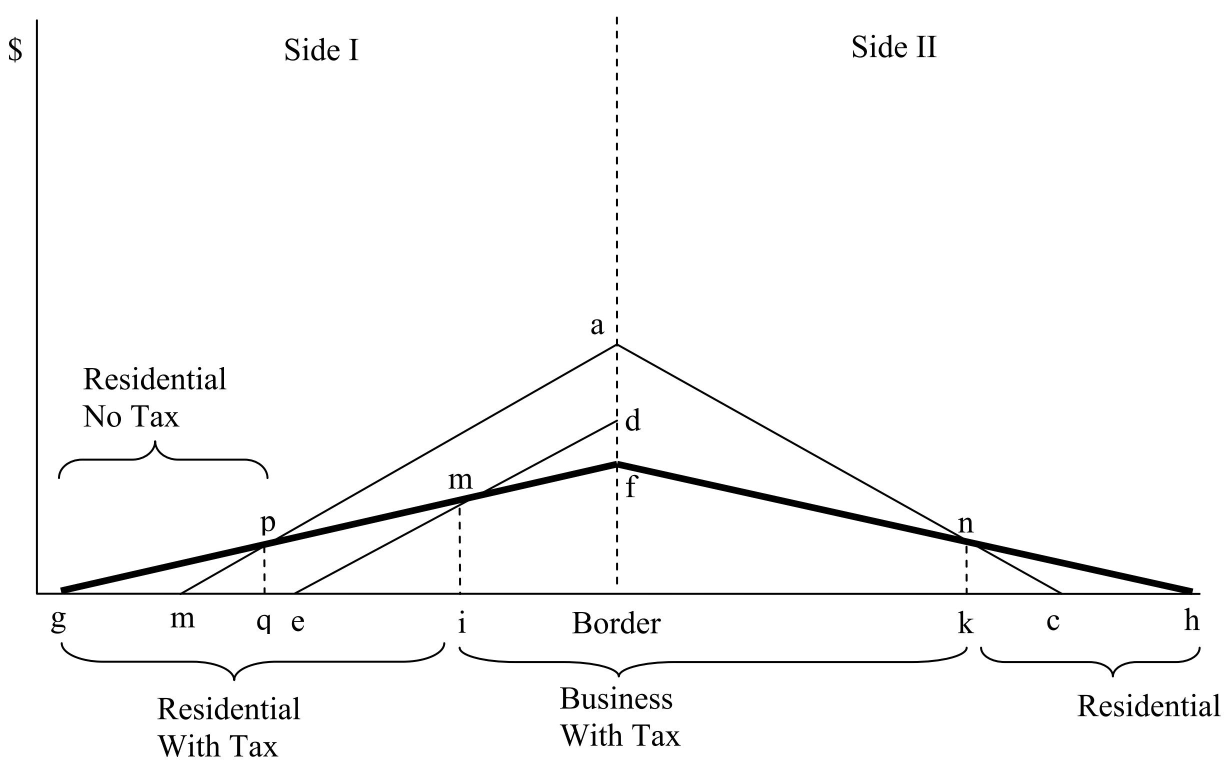


Figure 3: Price Plus Transport Costs

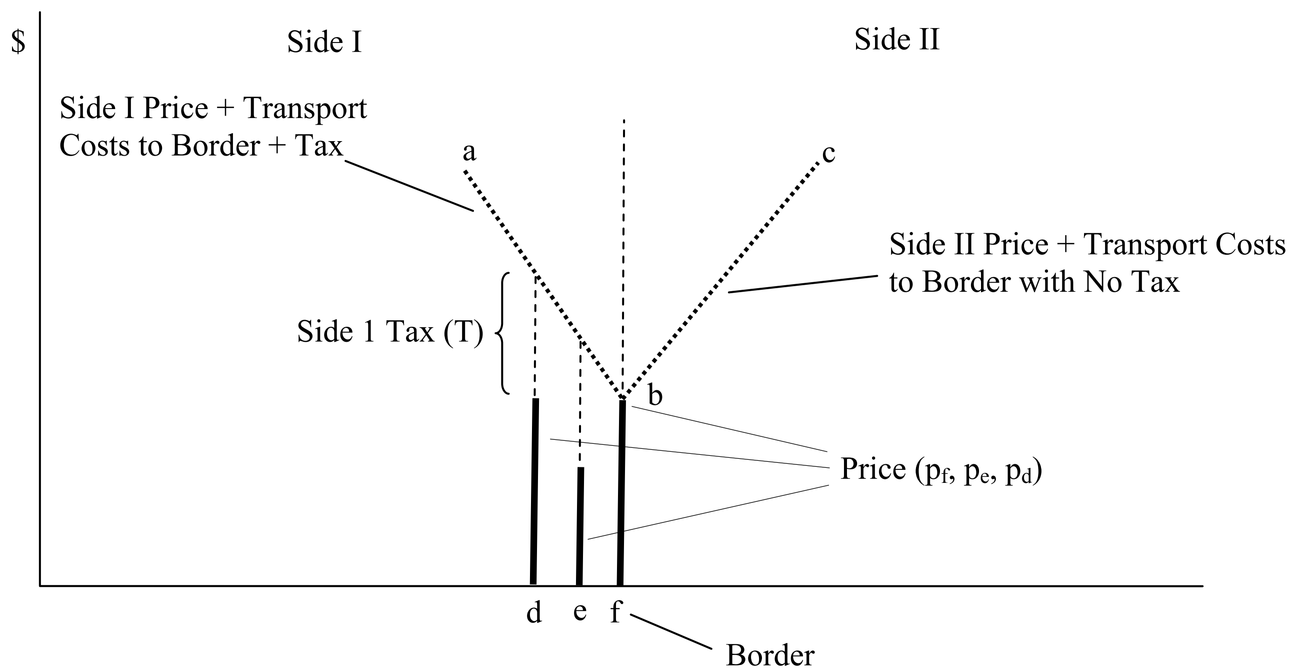


Figure 4: Two Sectors With Transport Costs

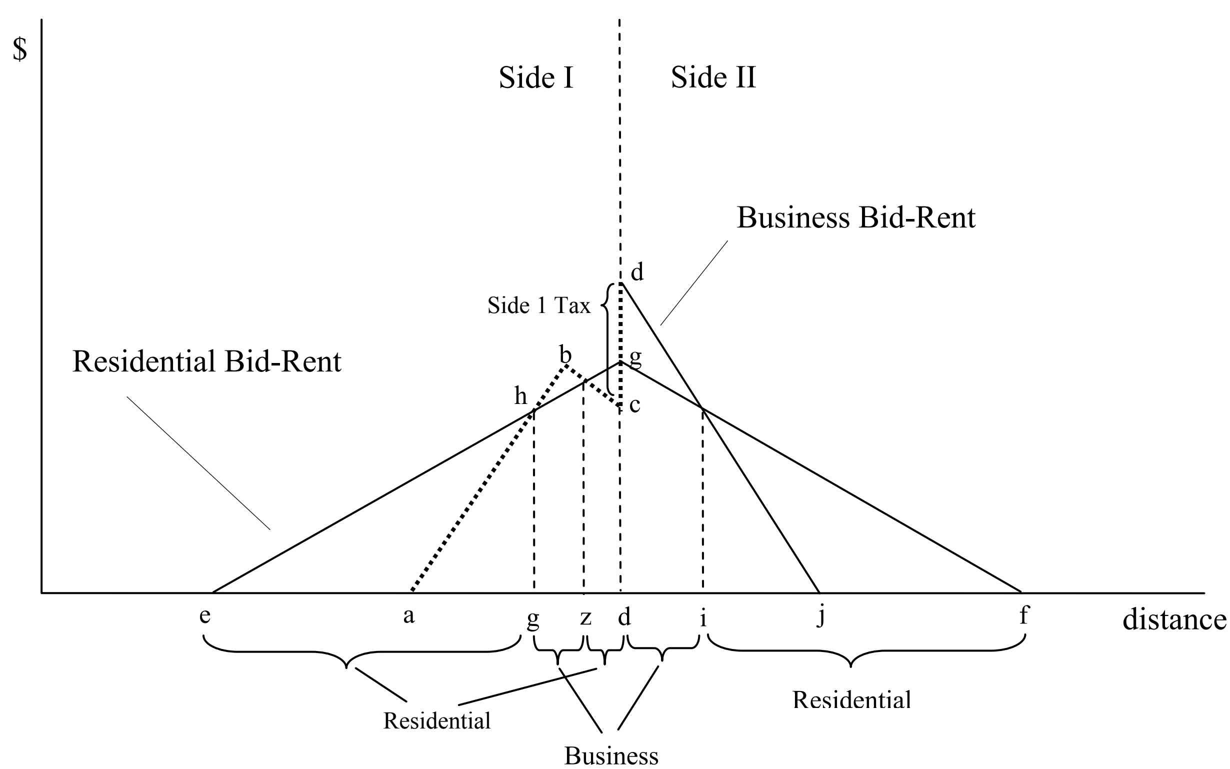


Figure 5: Wage Plus Commuting Costs

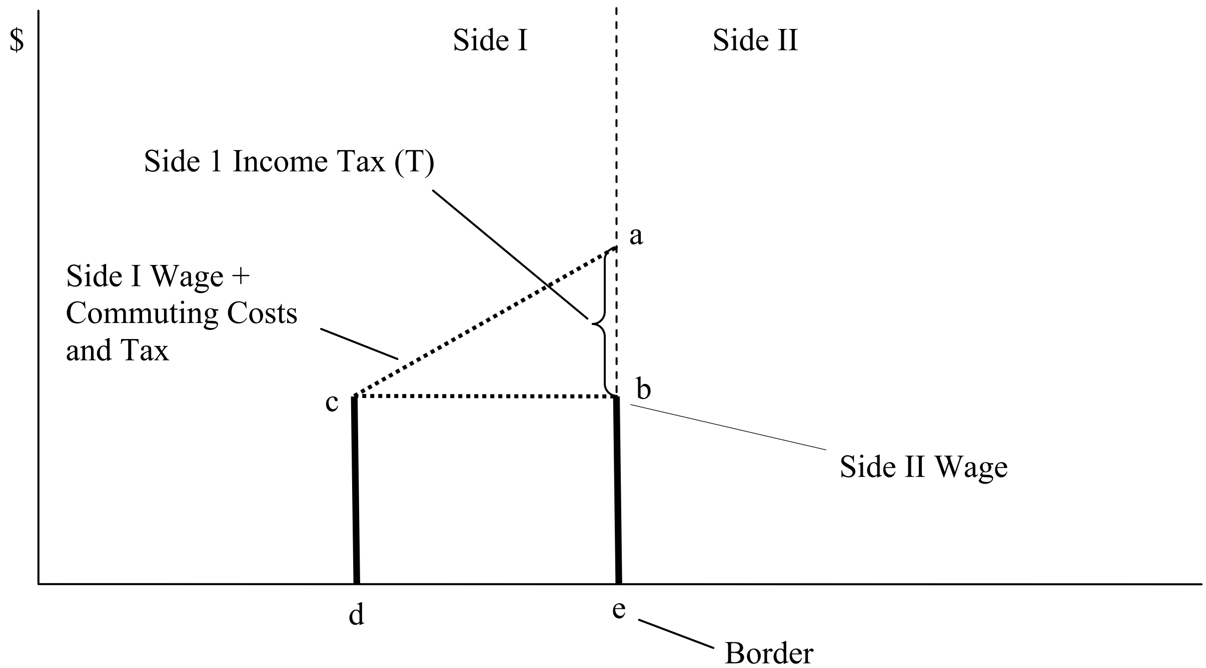


Figure 6: Creation of Wedge Pairs

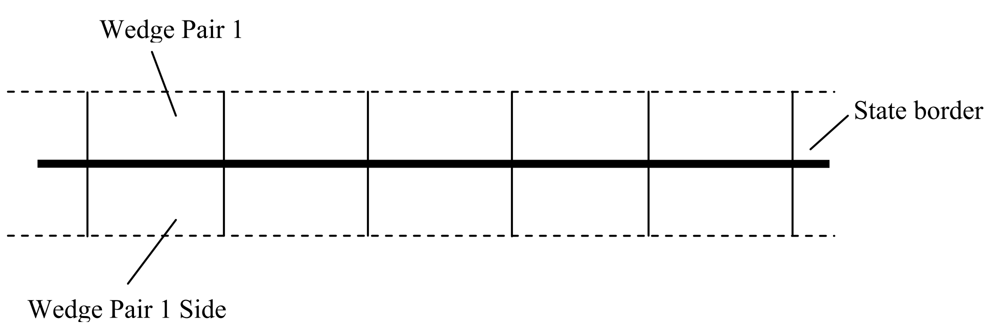


Table 1: State Revenue Shares and Expenditures for the 48 Contiguous States

Year	Intergovernmental Funding	Change in State Debt	Sales Tax Revenue	Household Income Tax Revenue	Corporate Income Tax Revenue	Miscellaneous Revenue Sources[a]	Expenditures per Capita
1993	0.2241	0.0471	0.1304	0.1240	0.0255	0.4490	$3,107
1994	0.2285	0.0539	0.1328	0.1223	0.0248	0.4376	$3,142
1995	0.2302	0.0401	0.1356	0.1243	0.0278	0.4420	$3,333
1996	0.2114	0.0873	0.1263	0.1183	0.0249	0.4320	$3,396
1997	0.2231	0.0076	0.1339	0.1290	0.0264	0.4799	$3,524
1998	0.2071	0.0536	0.1270	0.1290	0.0241	0.4591	$3,628
1999	0.2134	0.0517	0.1288	0.1315	0.0235	0.4511	$3,865
2000	0.2066	0.0616	0.1241	0.1281	0.0220	0.4574	$4,070
2001	0.2517	0.0528	0.1408	0.1459	0.0226	0.3862	$4,349
2002	0.2771	0.1055	0.1405	0.1366	0.0184	0.3219	$4,650
2003	0.2594	0.0933	0.1257	0.1182	0.0173	0.3860	$4,848
2004	0.2383	0.0726	0.1121	0.1058	0.0160	0.4553	$5,002
2005	0.2455	0.0571	0.1179	0.1162	0.0210	0.4423	$5,207
2006	0.2263	0.0835	0.1137	0.1160	0.0241	0.4364	$5,463
2007	0.2120	0.0702	0.1071	0.1132	0.0238	0.4736	$5,741

[a]Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.

Table 2: Change in Side-2 Share of New Business Arrivals[a]

Variable	Mean	Median	Standard Dev
0 up to 1 Mile	-0.0174	0.0000	0.5410
1 up to 5 Miles	-0.0148	0.0000	0.5331
5 up to 10 Miles	-0.0197	0.0000	0.5375
0 up to 10 Miles	-0.0149	0.0000	0.5305

[a]Based on 2005:Q4 new activity minus 2002:Q4 new activity for all wedge-pairs corresponding to a given distance band. Side-2 share of arrivals is defined as $A_2/(A_1+A_2)$, where A_i (i = 1, 2) is the number of newly created establishments on side *i*. The change in Side-2 share ranges from -1 to 1 given the differencing across sample years.

Table 3: Wedge-Pair Employment Counts per Square Mile for Different Distance Bands from the State Border in 2002:Q4[a]

Panel A: All Industries (Urbanization)

Distance	Observations[b]	5%	25%	50%	75%	95%	Mean	Standard Dev
0 up to 1 Mile	21,344	1.0239	4.2334	13.099	37.575	202.626	79.41	549.27
1 up to 5 Miles	20,443	1.0027	4.1323	10.983	23.912	166.937	57.85	341.59
5 up to 10 Miles	10,510	0.8836	3.3607	9.5663	20.809	119.739	56.76	244.16
0 up to 10 Miles	22,336	1.0385	4.3199	12.106	29.907	213.007	60.19	258.46

Panel B: All Industries (Urbanization) in Urban Areas

Distance	Observations[b]	5%	25%	50%	75%	95%	Mean	Standard Dev
0 up to 1 Mile	6,336	17.11	40.25	79.90	164.12	789.09	284.74	1157.75
1 up to 5 Miles	6,204	10.68	21.87	34.10	94.34	709.35	193.33	664.29
5 up to 10 Miles	2,861	7.08	20.64	39.96	98.67	1623.54	205.07	467.63
0 up to 10 Miles	6,464	13.76	31.08	63.66	169.08	748.24	205.78	497.07

[a]Geographic unit of observation is a "wedge-pair" as defined in the text. Panel A reports urbanization values based on employment per square mile pooling all industries together. Panel B reports corresponding values for own 2-digit industry employment.

[b]Observation counts differ by distance band category for two reasons. The first reason pertains to our use of a 20-by-20 mile grid square across the United States when matching wedge segments on either side of the state borders into wedge-pair observations as described in the appendix. Wedge pairs are created based on those segments of a grid square that extend into the target distance band on each side of the state border. In those instances where the grid square does not reach into the target distance band on both sides of the border no wedge-pair observation is created. The geographic nature of this GIS procedure ensures that there will be fewer instances in which wedge-pairs cannot be formed close to as opposed to further away from the state border, and this accounts for the greater number of observations for the 0 up to 1 mile band, versus 1 up to 5 mile band, versus 5 up to 10 mile band zones. The second reason observations differ is because both here in this table and throughout the paper we drop observations for which there are no newly created (within the last 12 months) establishments in a given wedge-pair/industry observation. This explains, for example, why the observation count for the 0 up to 10 mile band exceeds the observation count for the 0 up to 1 mile band: there are some instances in which no new activity is present within 1 mile of the state border, but new activity is found between 1 to 10 miles to the border.

Table 4: Impact of Differences in Sources of Tax Revenue on the Share Business Arrivals on Side 2[a]
(t-stats are reported in parenthesis using robust standard errors)

	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Corporate Income Tax	0.2721	0.3365	2.0441	0.2197
	(0.51)	(0.66)	(2.45)	(0.43)
Household Income Tax	-0.4579	-0.5239	-0.0917	-0.4845
	(-2.46)	(-2.85)	(-0.38)	(-2.70)
Sales Tax	-0.0580	0.0966	0.4732	0.0869
	(-0.39)	(0.64)	(2.38)	(0.61)
Miscellaneous Revenue Sources[a]	-0.1161	-0.1644	0.0839	-0.1710
	(-1.34)	(-1.88)	(0.66)	(-2.03)
Change in Debt	0.0338	-0.0066	0.1322	-0.0344
	(0.35)	(-0.07)	(0.94)	(-0.37)
Log(Expenditures)	0.0273	0.0403	0.1850	0.0072
	(0.54)	(0.79)	(2.45)	(0.15)
Observations	21344	20447	10507	22336
R-Squared	0.00	0.01	0.01	0.01
Root MSE	0.54	0.53	0.53	0.53
Industry Fixed Effects	54	54	54	54

[a]The dependent variable is the side-2 share of arrivals in 2005:Q4 minus the side-2 share of arrivals in 2002:Q4.
[b]Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.

Table 5a: Impact of Differences in Sources of Tax Revenue on Arrivals with Agglomeration Effects[a]
(t-stats are reported in parenthesis using robust standard errors)

	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Corporate Income Tax	-5.005	-2.9649	2.2688	-2.9430
	(-3.69)	(-2.32)	(1.22)	(-2.32)
Corporate * Urbanization[b]	1.6032	1.1628	-0.0272	1.0030
	(4.65)	(3.17)	(-0.05)	(3.05)
Household Income Tax	-0.7052	-0.6503	0.2434	-0.6997
	(-2.10)	(-1.92)	(0.59)	(-2.15)
Income * Urbanization	0.0583	-0.0200	-0.2561	0.0397
	(0.61)	(-0.19)	(-1.79)	(0.42)
Sales Tax	-0.7552	-0.5261	0.5830	-0.4454
	(-2.36)	(-1.55)	(1.35)	(-1.43)
Sales * Urbanization	0.3905	0.3525	0.0162	0.3145
	(3.82)	(2.91)	(0.11)	(3.08)
Miscellaneous Revenue Sources[c]	-0.4456	-0.2716	0.5087	-0.3666
	(-2.89)	(-1.71)	(2.43)	(-2.40)
Miscellaneous Rev Sources * Urbanization	0.1402	0.0408	-0.2130	0.0900
	(2.84)	(0.73)	(-2.69)	(1.82)
Change in Debt	-0.1939	-0.1722	0.5002	-0.1977
	(-1.09)	(-0.96)	(2.07)	(-1.14)
Change in Debt * Urbanization	0.1001	0.0752	-0.1656	0.0777
	(2.01)	(1.39)	(-2.25)	(1.60)
Log(Expenditures)	-0.0052	0.0827	0.4825	0.0788
	(-0.05)	(0.71)	(3.30)	(0.74)
Log(Expenditures) * Urbanization	0.0001	-0.0305	-0.1417	-0.0421
	(0.00)	(-0.75)	(-2.74)	(-1.25)
Observations	21344	20447	10507	22336
R-Squared	0.01	0.01	0.01	0.01
Root MSE	0.54	0.53	0.53	0.53
Industry Fixed Effects	54	54	54	54

[a]The dependent variable is the side-2 share of arrivals in 2005:Q4 minus the side-2 share of arrivals in 2002:Q4.
[b]Urbanization is the log(employment density) within a wedge pair in 2002:Q4.
[c]Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.

Table 5b: Implied Elasticities of Side-2 Arrival Share
With Respect to Cross-Border Differences in Tax Conditions[a]
(t-stats in parenthesis are based on robust standard errors)

% Change in Side-2 Arrivals in response to a doubling of Side-2's reliance on a given revenue source (or expenditure)[b]	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Corporate Income Tax Revenue Share				
Undeveloped Areas	-23.82%	-14.11%	10.71%	-14.01%
	(-3.69)	(-2.32)	(1.22)	(-2.32)
75th Percentile Employment Density – Undev. Areas[e]	23.73	17.21	0.40	22.34
	(4.65)	(3.17)	(0.05)	(3.05)
Household Income Tax Revenue Share				
Undeveloped Areas	-15.97%	-14.72%	5.51%	-15.84%
	(-2.10)	(-1.92)	(0.59)	(-2.15)
75th Percentile Employment Density – Undev. Areas[e]	4.14	-1.42	-18.18	2.83
	(0.61)	(-0.19)	(-1.79)	(0.42)
Sales Tax Revenue Share				
Undeveloped Areas	-16.18%	-11.22%	12.49%	-9.54%
	(-2.36)	(-1.55)	(1.35)	(-1.43)
75th Percentile Employment Density – Undev. Areas[e]	26.23	23.67	-1.09	21.12
	(3.82)	(2.91)	(0.11)	(3.08)
Miscellaneous Tax and License Revenue Share [c]				
Undeveloped Areas	-42.21%	-25.73%	48.18%	-34.72%
	(-2.89)	(-1.71)	(2.43)	(-2.40)
75th Percentile Employment Density – Undev. Areas[e]	41.64	12.12	63.26	26.73
	(2.84)	(0.73)	(-2.69)	(1.82)
Change in State Debt Revenue Share				
Undeveloped Areas	-2.72%	-2.42%	7.02%	-2.78
	(-1.09)	(-0.96)	(2.07)	(-1.14)
75th Percentile Employment Density – Undev. Areas[e]	4.41	3.31	7.29	3.42
	(2.01)	(1.39)	(2.25)	(1.60)
Log(Expenditure per capita)[d]				
Undeveloped Areas	-1.04%	16.54%	96.50%	15.76%
	(-0.05)	(0.71)	(3.30)	(0.74)
75th Percentile Employment Density – Undev. Areas[e]	0.06	-2.59%	-88.86	-26.40
	(0.00)	(-0.75)	(-2.74)	(-1.25)

[a]Estimates are based on coefficient values from Table 5a with the base side-2 share of arrivals set equal to 0.5. Employment density is set to 1 worker per square mile for undeveloped areas and 23 workers per square mile for the 75th percentile (see Table 3).
[b] All calculations hold Side-1 tax (expenditure) conditions constant and assume equal tax (expenditure) values for adjacent states in 2002 with values set equal to the mean across all states in 2007. The 2002 side-2 share of arrivals is also set at 50 percent.
[c] Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.
[d]Texas had the minimum state expenditures per capita in 2007 of any state, at $3,831. See the Tax Foundation website for details at http://www.taxfoundation.org/research/show/287.html
[e]T-ratio in parentheses is from Table 5a and is a test of whether the main coefficient varies with the degree of urbanization.

Table 6: Reciprocal Agreements and Corporate Tax Apportionment[a]
(t-stats are reported in parenthesis using robust standard errors)

	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Corporate Income Tax	-10.2641	-9.2699	-3.8363	-8.4514
	(-3.44)	(-2.82)	(-0.94)	(-2.83)
Corporate * Urbanization[b]	4.9890	4.8651	3.5544	3.8917
	(5.12)	(4.12)	(2.44)	(4.06)
Corporate * 2002 Sales Share Apportionment	11.6336	13.5283	11.2828	11.9204
	(1.98)	(2.07)	(1.50)	(2.02)
Corporate * 2002 Sales Share Apportionment * Urbanization	-7.2660	-7.8961	-7.0186	-6.1665
	(-3.73)	(-3.36)	(-2.58)	(-3.28)
Household Income Tax	-0.8099	-0.8424	-0.1816	-0.9021
	(-2.34)	(-2.39)	(-0.42)	(-2.68)
Income * Urbanization	0.0968	0.03563	-0.0780	0.1033
	(0.99)	(0.33)	(-0.52)	(1.08)
Household Income Tax * Recip Agree YES	1.7368	1.7536	3.2340	2.1067
	(1.68)	(1.87)	(2.59)	(2.31)
Household Income Tax * Recip Agree YES * Urbanization	-0.5227	-0.5539	-1.0400	-0.6031
	(-1.92)	(-2.03)	(-2.72)	(-2.50)
Additional controls from Table 5a[c]	Yes	Yes	Yes	Yes
Observations	21344	20447	10507	22336
R-Squared	0.01	0.01	0.02	0.01
Root MSE	0.54	0.53	0.53	0.53
Industry Fixed Effects	54	54	54	54

[a]The dependent variable is the side-2 share of arrivals in 2005:Q4 minus the side-2 share of arrivals in 2002:Q4.
[b]Urbanization is the log(employment density) within a wedge pair in 2002:Q4.
[c]All other controls from Table 5a are included in the regressions but their coefficients are suppressed.

Table 7: Tax Effects Stratified by Industry for Activity Within 1 Mile of the State Border[a]
(Absolute value of t-stats are reported in parenthesis using robust standard errors)

	All	Manufacturing: Sic20to39	Wholesale: Sic50to51	Retail: Sic52to59	Finance/Ins Sic 60to64, 67	Service: Sic70to89
Corporate Income Tax	-10.2641	-14.9331	-14.8273	-6.1924	-30.5104	-18.2063
	(-3.44)	(-1.28)	(-1.27)	(-0.99)	(-2.54)	(-3.76)
Household Income Tax	-0.8099	-4.5514	-2.9940	0.1422	-2.3944	-0.1242
	(-2.34)	(-3.12)	(-2.17)	(0.20)	(-1.37)	(-0.23)
Sales Tax	-0.7136	-0.7331	-2.7864	-0.1380	-3.8539	-0.7814
	(-2.22)	(-0.64)	(-1.98)	(-0.21)	(-2.50)	(-1.51)
Miscellaneous Revenue Sources[c]	-0.4574	-1.4261	-0.6812	-0.0085	-0.2471	-0.5860
	(-2.81)	(-2.34)	(-1.07)	(-0.02)	(-0.33)	(-2.21)
Change in Debt	-0.1964	-1.5405	0.0578	0.4762	1.2317	-0.1470
	(-1.04)	(-2.12)	(0.08)	(1.21)	(1.57)	(-0.48)
Log(Expenditures)	-0.0214	0.1680	1.1062	-0.0010	-1.4168	-0.5374
	(-0.19)	(0.36)	(2.07)	(-0.04)	(-2.75)	(-2.95)
Additional controls from Tables 5a and 6[c]	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21344	1531	1313	4916	913	8156
R-Squared	0.01	0.04	0.05	0.01	0.06	0.01
Root MSE	0.54	0.58	0.56	0.55	0.5	0.53
Industry Fixed Effects	54	18	2	8	6	15

[a]The dependent variable is the side-2 share of arrivals in 2005:Q4 minus the side-2 share of arrivals in 2002:Q4.
[b]Urbanization is the log(employment density) within a wedge pair in 2002:Q4.
[c]All other controls from Tables 5a and 6 are included in the regressions but their coefficients are suppressed.

Table 8: Impact of Tax Foundation's State Business Tax Climate Index on Arrivals[a]
(t-stats are reported in parenthesis using robust standard errors)

	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Business Tax Index[b]	-0.0414	-0.0372	-0.0275	-0.0362
	(-2.21)	(-2.18)	(-1.26)	(-2.16)
Business Tax Index * Urbanization[c]	0.0139	0.0112	0.0039	0.0105
	(2.95)	(2.51)	(0.66)	(2.55)
Log(Expenditures)	0.1848	0.1601	0.2420	0.1746
	(2.51)	(2.03)	(2.46)	(2.38)
Log(Expenditures) * Urbanization	-0.0694	-0.0565	-0.0664	-0.0745
	(-59)	(-1.79)	(-1.59)	(-2.78)
Observations	21344	20447	10507	22336
R-Squared	0.00	0.01	0.01	0.01
Root MSE	0.54	0.53	0.53	0.53
Industry Fixed Effects	54	54	54	54

[a]The dependent variable is the side-2 share of arrivals in 2005:Q4 minus the side-2 share of arrivals in 2002:Q4.
[b]The Business Tax Index was obtained from the Tax Foundation's State Business Tax Climate Index Study. The Index variable is the change from 2003 to 2006 in the difference in the index between adjacent state-pairs.
[c]Urbanization is the log(employment density) within a wedge pair in 2002:Q4.

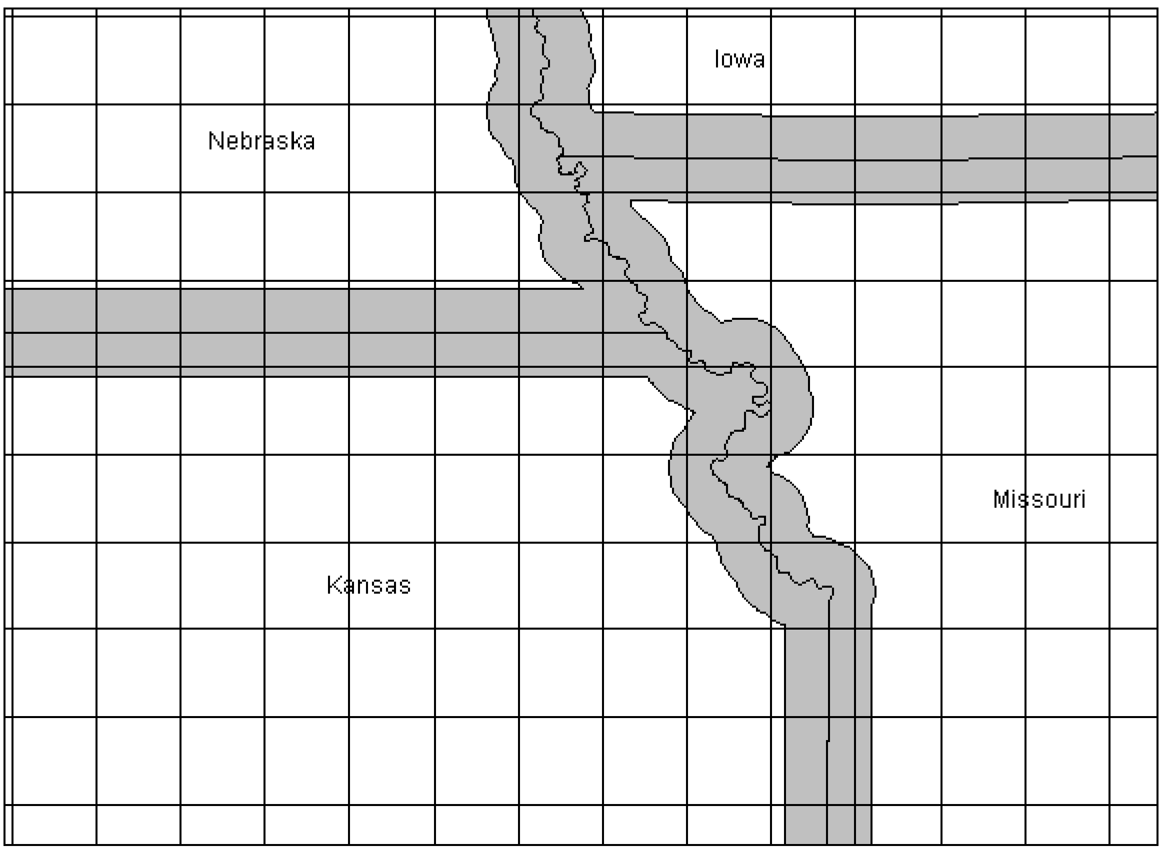
Appendix A: Creation of Wedge-Pairs Along the State Borders

Although we initially obtain our business data at the zipcode level, the geographic shape and size of zipcodes is extremely heterogeneous making cross-border comparisons of "adjacent" zipcodes difficult. As an alternative, we use Geographic Information Systems (GIS) software (MapInfo and MapBasic) to recode the data to wedge polygons that can more readily be matched across state borders as described earlier. To do this we first create buffer zones extending one, five, and ten miles out on either side of a state border. If all borders were always straight we could then easily splice these distance buffers into wedges where each wedge would have an opposite directly across the state border of identical size and shape. Figure 5 provides an illustration of such a situation as described in the text. But because state borders are often not straight a more complicated procedure was developed to facilitate creation of matched polygons or "wedge-pairs" on opposite sides of a state border.

Our solution to the problem is illustrated in Figure A-1. The figure provides a snapshot of the border region of Nebraska, Kansas, Missouri, and Iowa. Both for this region and for the entire United States, 20-by-20 mile grid was overlaid on 10-mile wide distance buffers (shown in the shaded areas in the figure) drawn on either side of a state boundary. Polygons are then created within each individual grid square corresponding to the portion of area within a given distance buffer that lies within the square. Opposing polygons on either side of the state border within the given grid square and within a distance buffer of similar distance to the border are then matched. That matched pair becomes a "wedge-pair" as described in the text. As further described in the text, we then computed the geographic correspondence between zipcode and wedge-polygon geography to calculate business activity in each edge-polygon and wedge pair.

Two points should be emphasized regarding this procedure. First, it ensures that the polygons associated with sides 1 and 2 of a given wedge-pair are opposite each other across the state border and also of similar distance from the border. Second, the two polygons associated with a given wedge pair will typically be of different size because the state border is unlikely to divide a given grid-square into equal halves. This is also evident in Figure A-1. For our dependent variables in the estimation this is not a problem because measure the change in side-2's share of business arrivals between periods. Temporal differencing controls for cross-border differences in the relative size of the corresponding wedge-pair polygons. When measuring the level of agglomeration associated with a given wedge-pair we address the problem by using employment density per square mile.

Figure A-1: 20-by-20 mile Grid Squares Overlaid on 10-mile State Border Buffers



Appendix B: Supplemental Tables

Table B-1: State Income Tax Reciprocal Agreements[a]

State	Has Reciprocal Agreement with:	Year of Inception	State	Has Reciprocal Agreement with:	Year of Inception
Illinois	Iowa	1973	Maryland	Pennsylvania	Before 2002
	Kentucky	1971		Virginia	Before 2002
	Michigan	Before 2002		West Virginia	Before 2002
	Wisconsin	1973	Michigan	Minnesota	Before 2002
Indiana	Kentucky	Before 2002		Ohio	Before 2002
	Michigan	Before 2002		Wisconsin	Before 2002
	Ohio	Before 2002	Minnesota	North Dakota	1958
	Pennsylvania	Before 2002		Wisconsin	1968
	Wisconsin	Before 2002	Montana	North Dakota	Before 2002
Kentucky	Michigan	1968	New Jersey	Pennsylvania	Before 2002
	Ohio	1972	Ohio	Pennsylvania	Before 2002
	West Virginia	1965		West Virginia	Before 2002
	Wisconsin	Before 2002	Pennsylvania	Virginia	Before 2002
	Virginia	1964		West Virginia	Before 2002
			Virginia	West Virginia	Before 2002

[a] The reciprocal agreement data comes from www.gaebler.com. Note that DC is not included in this list despite having reciprocal agreements because DC is not included in this study.

Table B-2: Impact of Differences in Sources of Tax Revenue Interacted with Urbanization Measures on Arrivals With Controls for Reciprocal Agreements and Corporate Tax Apportionment[a]
(t-stats are reported in parenthesis using robust standard errors)

	0 up to1 Miles	1 up to 5 Miles	5 up to 10 Miles	0 up to 10 Miles
Corporate Income Tax	-10.2641	-9.2699	-3.8363	-8.4514
	(-3.44)	(-2.82)	(-0.94)	(-2.83)
Corporate * Urbanization[b]	4.9890	4.8651	3.5544	3.8917
	(5.12)	(4.12)	(2.44)	(4.06)
Corporate * 2002 Sales Share Apportionment	11.6336	13.5283	11.2828	11.9204
	(1.98)	(2.07)	(1.50)	(2.02)
Corporate * 2002 Sales Share Apportionment * Urbanization	-7.2660	-7.8961	-7.0186	-6.1665
	(-3.73)	(-3.36)	(-2.58)	(-3.28)
Household Income Tax	-0.8099	-0.8424	-0.1816	-0.9021
	(-2.34)	(-2.39)	(-0.42)	(-2.68)
Income * Urbanization	0.0968	0.03563	-0.0780	0.1033
	(0.99)	(0.33)	(-0.52)	(1.08)
Household Income Tax * Recip Agree YES	1.7368	1.7536	3.2340	2.1067
	(1.68)	(1.87)	(2.59)	(2.31)
Household Income Tax * Recip Agree YES * Urbanization	-0.5227	-0.5539	-1.0400	-0.6031
	(-1.92)	(-2.03)	(-2.72)	(-2.50)
Sales Tax	-0.7136	-0.4447	0.1609	-0.4568
	(-2.22)	(-1.31)	(0.36)	(-1.46)
Sales * Urbanization	0.3446	0.2885	0.1456	0.2981
	(3.34)	(2.36)	(0.97)	(2.92)
Miscellaneous Revenue Sources[c]	-0.4574	-0.2794	0.3509	-0.3946
	(-2.81)	(-1.66)	(1.60)	(-2.43)
Miscellaneous Rev Sources * Urbanization	0.1395	0.0326	-0.1547	0.0975
	(2.76)	(0.57)	(-1.91)	(1.92)
Change in Debt	-0.1964	-0.1585	0.4990	-0.2001
	(-1.04)	(-0.82)	(1.96)	(-1.07)
Change in Debt * Urbanization	0.0869	0.0509	-0.1955	0.0672
	(1.66)	(0.87)	(-2.55)	(1.30)
Log(Expenditures)	-0.0214	0.1008	0.3478	0.0648
	(-0.19)	(0.84)	(2.22)	(0.59)
Log(Expenditures) * Urbanization	0.0169	-0.0276	-0.0583	-0.0247
	(0.49)	(-0.67)	(-1.06)	(-0.72)
Observations	21344	20447	10507	22336
R-Squared	0.01	0.01	0.02	0.01
Root MSE	0.54	0.53	0.53	0.53
Industry Fixed Effects	54	54	54	54

[a]The dependent variable is the share of arrivals on side two in 2005:Q4 minus the share of arrivals on side two in 2002:Q4. The share of arrivals is represented as: $A_2/(A_1 + A_2)$.
[b]Urbanization is the log(total employment level) for all industries within a wedge pair in 2002:Q4.
[c]Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.

Table B-3: Impact of Differences in Sources of Tax Revenue Stratified by Industry 0 up to 1 Mile from the Border, Allowing for the Apportionment of Corporate Income Tax to be Weighted by the Sales Proportion[a]
(Absolute value of t-stats are reported in parenthesis using robust standard errors)

	All	Manufacturing: Sic20to39	Wholesale: Sic50to51	Retail: Sic52to59	Finance/Ins Sic 60to64, 67	Service: Sic70to89
Corporate Income Tax	-10.2641	-14.9331	-14.8273	-6.1924	-30.5104	-18.2063
	(-3.44)	(-1.28)	(-1.27)	(-0.99)	(-2.54)	(-3.76)
Corporate * Urbanization[b]	4.9890	1.7857	7.4336	3.7898	9.2065	7.5287
	(5.12)	(0.51)	(1.89)	(1.79)	(2.66)	(4.62)
Corporate * 2002 Sales Share Apportionment	11.6336	19.4857	12.6641	1.9603	66.4232	32.6913
	(1.98)	(0.86)	(0.53)	(0.16)	(2.81)	(3.54)
Corporate * Urbanization * 2002 Sales Share Apportionment	-7.2660	-1.7432	-10.7079	-5.8071	-15.6987	-12.9196
	(-3.73)	(-0.24)	(-1.33)	(-1.36)	(-2.29)	(-4.09)
Household Income Tax	-0.8099	-4.5514	-2.9940	0.1422	-2.3944	-0.1242
	(-2.34)	(-3.12)	(-2.17)	(0.20)	(-1.37)	(-0.23)
Income * Urbanization	0.0968	0.4867	0.1580	0.0647	0.4093	-0.0299
	(0.99)	(1.27)	(0.41)	(0.31)	(0.94)	(-0.19)
Household Income Tax * Recip Agree YES	1.7368	0.7249	-3.5371	4.6844	15.3570	-0.0315
	(1.68)	(0.16)	(-0.75)	(2.12)	(3.82)	(-0.02)
Household Income Tax * Recip Agree YES * Urbanization	-0.5227	0.0021	1.3822	-1.2620	-3.2842	-0.3261
	(-1.92)	(0.00)	(1.11)	(-2.14)	(-3.44)	(-0.80)
Sales Tax	-0.7136	-0.7331	-2.7864	-0.1380	-3.8539	-0.7814
	(-2.22)	(-0.64)	(-1.98)	(-0.21)	(-2.50)	(-1.51)
Sales * Urbanization	0.3446	0.5015	0.8955	0.1582	0.7831	0.3417
	(3.34)	(1.44)	(2.01)	(0.72)	(1.81)	(2.03)
Miscellaneous Revenue Sources[c]	-0.4574	-1.4261	-0.6812	-0.0085	-0.2471	-0.5860
	(-2.81)	(-2.34)	(-1.07)	(-0.02)	(-0.33)	(-2.21)
Miscellaneous Rev * Urbanization	0.1395	0.2062	0.2163	0.0830	-0.0333	0.1756
	(2.76)	(1.13)	(1.12)	(0.75)	(-0.16)	(2.10)
Change in Debt	-0.1964	-1.5405	0.0578	0.4762	1.2317	-0.1470
	(-1.04)	(-2.12)	(0.08)	(1.21)	(1.57)	(-0.48)
Change in Debt * Urbanization	0.0869	0.3388	0.1263	-0.0770	-0.2161	0.0154
	(1.66)	(1.86)	(0.58)	(-0.68)	(-1.04)	(0.18)
Log(Expenditures)	-0.0214	0.1680	1.1062	-0.0010	-1.4168	-0.5374
	(-0.19)	(0.36)	(2.07)	(-0.04)	(-2.75)	(-2.95)
Log(Expenditures) * Urbanization	0.0169	-0.3208	-0.1449	0.0709	0.3966	0.1631
	(0.49)	(-2.26)	(-0.91)	(0.98)	(2.95)	(2.96)
Observations	21344	1531	1313	4916	913	8156
R-Squared	0.01	0.04	0.05	0.01	0.06	0.01
Root MSE	0.54	0.58	0.56	0.55	0.5	0.53
Industry Fixed Effects	54	18	2	8	6	15

[a]The dependent variable is the share of arrivals on side two in 2005:Q4 minus the share of arrivals on side two in 2002:Q4. The share of arrivals is represented as: $A_2/(A_1 + A_2)$.
[b]Urbanization is the log(total employment level) in the own industry within a wedge pair in 2002:Q4.
[c]Miscellaneous revenue sources include selective taxes, license taxes, other taxes, insurance trust revenue, utility revenue, liquor store revenue, miscellaneous general revenue, and current charges.

Table B-4
Tax Foundation Index by State[a]

	Business Tax Index			Business Tax Index	
	2003	2006		2003	2006
ALABAMA	5.49	5.61	MONTANA	5.52	5.56
ALASKA	3.84	3.67	NEBRASKA	4.36	4.22
ARIZONA	5.03	5.03	NEVADA	10	10
ARKANSAS	4.36	4.17	NEW HAMPSHIRE	4.35	4.46
CALIFORNIA	3.43	4.43	NEW JERSEY	4.04	2.74
COLORADO	5.85	6.06	NEW MEXICO	5.03	5.01
CONNECTICUT	5.27	5.59	NEW YORK	4.93	5.02
DELAWARE	5.1	5.15	NORTH CAROLINA	5.14	5.22
FLORIDA	5.53	5.7	NORTH DAKOTA	4.37	4.62
GEORGIA	5.74	5.91	OHIO	4.37	4.54
HAWAII	5.18	5.14	OKLAHOMA	5.74	5.91
IDAHO	5.37	5.47	OREGON	5.08	5.16
ILLINOIS	6	5.61	PENNSYLVANIA	4.75	4.96
INDIANA	5.5	5.5	RHODE ISLAND	5.19	5.13
IOWA	4.33	3.82	SOUTH CAROLINA	5.59	5.78
KANSAS	4.17	4	SOUTH DAKOTA	10	10
KENTUCKY	4.66	4.31	TENNESSEE	5.36	5.83
LOUISIANA	5.32	4.91	TEXAS	5.33	5.53
MAINE	4.24	3.82	UTAH	5.91	6.07
MARYLAND	5.83	5.96	VERMONT	4.91	4.19
MASSACHUSETTS	4.7	4.61	VIRGINIA	5.74	5.91
MICHIGAN	3.34	3.4	WASHINGTON	5.65	5.54
MINNESOTA	4.35	4.31	WEST VIRGINIA	5.07	5.11
MISSISSIPPI	4.8	4.94	WISCONSIN	5.12	5.16
MISSOURI	6.03	6.19	WYOMING	10	10

[a] Source: The Tax Foundation.