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LEADERS, FOLLOWERS, AND ASYMMETRIC LOCAL TAX POLICY DIFFUSION

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ABSTRACT. Complementing recent theoretical models of tax competition with endogenous leadership, we empirically model local policy diffusion as a dynamic asymmetric process. Using a setting where local option sales taxes rapidly transitioned from nonexistence to ubiquity, we construct a policy leadership index to classify jurisdictions as leaders or followers. Using models that control for vertical tax competition effects, we show how asymmetric leader–follower dynamics characterize horizontal tax competition over the three decades that follow. A placebo test further supports our main conclusions. This methodological approach could be adapted to other settings where policies exhibit both extensive and intensive margins.

The existence and identity of a leader matter a lot in tax competition.

(Kempf and Rota-Graziosi, 2010, p. 771)

1. INTRODUCTION

As Shipan and Volden (2012) note, "Extending the [extensive] policy diffusion literature beyond initial policy adoption is warranted and long overdue" (p. 6). Heterogeneity among jurisdictions creates important asymmetries regarding the timing of adoption as well as the extent or intensity of implementation. Diffusion mechanisms can involve learning and imitation (e.g., tax mimicking and yardstick competition) as well as strategic interaction (e.g., tax competition).[1] Endogeneity of the strategic timing of implementation choices creates nuanced leader-follower dynamics (Kempf and Rota-Graziosi, 2010). Although the importance of leader-follower dynamics has been considered in the context of oligopoly markets, international trade, monetary policy, and even international corporate tax policy, it has largely been ignored when it comes to local governmental policy diffusion.[2] Notably, questions arise concerning how to identify leaders and whether their leadership persists past the initial period of policy adoption.

In this paper, we explore policy diffusion over newly authorized local options sales tax (LOST) programs where some jurisdictions (leaders) adopted earlier and impose higher rates than others (followers). We develop a generalizable approach where the evolution of

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[1]Berry and Berry (2007) and Shipan and Volden (2012) provide recent overviews of the policy diffusion literatures in political science and public administration.

[2]To our knowledge only two exceptions exist: de Mello (2008) and Janeba and Osterloh (2013). These papers are discussed below.

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tax policy decisions during the early periods of diffusion endogenously determines multiple leaders. In the first stage, we construct a leadership index (LI) that considers both the extensive (timing of policy adoption) and intensive (rate levels) margins. In the second stage, we use the remaining 34 years of the panel to estimate strategic tax competition models, finding evidence that the designated leaders and followers play asymmetric roles throughout the later part of the study period.

We make several contributions to the literature. First, we provide a novel empirical application of Kempf and Rota-Graziosi's (2010) theoretical model of endogenous policy leadership. Second, we show that leaders retain their influence over several decades following initial adoption. To our knowledge, ours is the first paper to directly investigate the durability of leadership dynamics.[3] Third, in a literature where available mechanisms for identifying multiple leaders and followers have been elusive, we construct a data-driven approach for selecting multiple leaders. In contrast to Janeba and Osterloh (2013) who employ an extensive survey of local elected public officials, we utilize a long panel containing the policy outcome of interest. Finally, our approach could be adapted to other settings where multiple levels of government have the authority to tax the same base (e.g., federal and state personal income taxes).

Our empirical application includes comprehensive coverage of annual municipal and county LOSTs implemented in Oklahoma from initial state authorization in 1966 through 2010. Used in over two-thirds of U.S. states, LOSTs provide more revenue than any other local fiscal instrument, save the property tax (Brunori, 2007). Focusing on policy diffusion in a single state circumvents the empirical difficultly of controlling for state-specific institutional features across different environments (Fletcher and Murray, 2006).[4] Of the 506 jurisdictions in our data, our utilized LI ultimately classifies 469 as followers and 37 as leaders. Our second stage results show how persistent leadership affects both horizontal and vertical strategic interactions. Although followers display within period tax rate comovement, we find no evidence that they influence one another or leaders. In contrast, followers are more likely to raise their rates during the three-year period following a leader's rate increase.

Leaders display distinctly different patterns. In fact, leaders show few reactions to rate changes in other jurisdictions, except for reactions to rate increases at the parent county level and state border effects. Using a placebo test for additional validation, we find that randomly selected jurisdictions do not influence others in the way our actual designated leaders do.

The following section frames our work and reviews the existing literature. Section 3 presents a brief history of LOSTs in the U.S. Section 4 introduces our data. Section 5 outlines the construction of the LI. Section 6 introduces our empirical approach to modeling the determinants of LOST rate setting behavior, with a focus on leadership-driven competition asymmetries. Section 7 presents our results and the final section concludes.

2. LOCAL TAX POLICY DIFFUSION WITH STRATEGIC INTERACTION

Policy diffusion among subnational governments arises through various mechanisms (Shipan and Volden, 2008; Maggetti and Gilardi, 2015). In a Tiebout setting, jurisdictions set policy to serve constituent demands. Policy adoption/implementation simply reflects

[3]We thank an anonymous referee for pointing this out.

[4]Agrawal (2014, 2015) has recently compiled nationwide LOST tax rate data for a 10-year period. The advantage of our 45-year panel is that it reports initial adoptions as well as annual tax revenues.

the heterogeneous distribution of preferences held by mobile citizen voters. Horizontal interaction also influences jurisdictions in decentralized systems of government (Rincke, 2007).

In regards to fiscal policy innovations, strategic interaction can arise for a number of reasons including benefits spillovers, competition for a mobile tax base, and tax mimicking behavior (Wilson, 1999; Zodrow, 2010; Lyytikäinen, 2012). In tax competition models (Mintz and Tulkens, 1986; Wildasin, 1988, 1989), competing jurisdictions affect the rate of return on fiscal policy choices. Inefficient outcomes occur when a tax in one jurisdiction affects the utility of residents in another. For the case of a mobile tax base, equilibrium tax rates are set too low, causing an under provision of public goods.

The emerging literature on the nature of asymmetric tax policy interaction generally explores horizontal and/or vertical spillovers via differences in size. Bucovetsky (1991), Haufler and Wooton (1999), and Peralta and van Ypersele (2005) all conclude that, in equilibrium, larger countries optimally tax at higher rates than smaller countries. Recent work by Exbrayat (2013) and Exbrayat and Geys (2014) also provide interesting theoretical and empirical findings along these lines. Using a three-country setting with quasi-linear utility functions and a lump-sum tax on capital invested in a country, they find that asymmetry of population implies that larger markets are more profitable for firms than smaller markets. They highlight the importance of modeling differences in tax differentials in a more realistic, multijurisdiction framework.

Subnational studies uncover more nuanced spillovers with respect to size differentials. Using German data, Buettner (2001) finds that small jurisdictions experience fiscal spillovers when larger neighboring jurisdictions change their local business taxes. Hayashi and Boadway (2001) find asymmetries with respect to vertical and horizontal channels of tax competition: Canadian provinces were found to lower (increase) corporate income taxes in response to federal tax rate (other provinces') increases. Investigations at the U.S. local level have also identified horizontal and vertical asymmetries (Wu and Hendrick, 2009). Geys and Osterloh (2013) find that perceived local horizontal competition can transcend national borders. Baldwin and Krugman (2004) attribute differences in taxes between core and periphery areas to agglomeration economies, where higher rates in the core influence rates in the periphery. Using municipal taxes in the U.S., Hill (2008) finds similar evidence that agglomeration influences local tax policy.

Fiscal policy interactions are often modeled within a simultaneous move Nash equilibrium framework (Wilson, 1986; Zodrow and Mieskowski, 1986; Wildasin, 1988). However, recent work considers potential asymmetries regarding the timing of decisions. In vertical tax competition models, the higher order government moves first in a Stackelberg setting, whereas in horizontal models first movers are generally identified by size or agglomeration (Baldwin and Krugman, 2004). Kempf and Rota-Graziosi (2010) extend the literature by investigating the implications of endogenous leadership in models with asymmetric tax competition. They find the extent of asymmetry among jurisdictions influences equilibrium outcomes, and that smaller jurisdictions can be leaders. Unlike previous work, they estimate less downward pressure on tax rates than models ignoring the endogenous timing of moves.

The absence of a robust mechanism for sorting leaders and followers in dynamic settings impedes empirical investigations. In some cases, leaders emerge from the context of the setting considered. For example, Altshuler and Goodspeed (2015) focus on international corporate tax competition and characterize the U.S. as a Stackelberg leader, with European countries following. While the theory motivating their application is similar to our own, they do not observe early periods of policy adoption. They identify leaders and test for asymmetric effects using the same data, whereas we use separate portions of our panel to accomplish the tasks distinctly. In vertical tax competition models, national governments generally move first, while subnational governments are treated as followers (Besley and Rosen, 1998; Goodspeed, 2000, 2002; Esteller-Moré and Solé-Ollé, 2001). However, in most contexts involving horizontal spillovers, it is difficult to predetermine leaders and followers.

To our knowledge, only two empirical studies consider asymmetries driven by sequential policy decisions made by subnational governments. De Mello (2008) considers local VAT rates in Brazil where a single Stackelberg leader is designated among local jurisdictions. Using data from 1985 to 2001, neighbors are found to react strongly to one another's VAT policies, as well as to that of the regional leader. Janeba and Osterloh (2013) survey elected mayors in Baden-Württenberg, Germany to learn which local jurisdictions are perceived as competitors regarding business and land taxation. Smaller jurisdictions are found to rely less on capital taxation, and competition within regions plays a role in sequential tax rate setting. While their approach allows for multiple leaders, it may not be feasible to conduct a survey, particularly when a large number of jurisdictions are involved. Furthermore, a survey of current perceptions may not reveal the evolution of policy choices over time or the extent to which leadership is persistent.

In contrast, we develop a data-driven procedure for selecting leaders and followers, respecting the historical evolution of the timing of initial implementation as well as subsequent rate changes. Specifically, we create a LI that identifies multiple leaders and followers based on their early tax policy decisions. This dichotomy is then used to investigate potentially asymmetric fiscal spillovers in the final 34 years of our study period. Our approach is generalizable to situations where data can be parsed into an initial adoption and diffusion stage and subsequent stages, such that the relevant margins of strategic interactions move beyond questions of whether the policy is present or not. Given that many tax policies involve both intensive and extensive margins, this approach may be widely applicable.

An additional feature of our approach is that we can directly address the question of whether leaders *retain* their influence on others over time. The determinants of influence may be pervasive in many policy settings. For instance, greater administrative capacity may enhance the likelihood of an early adoption and may directly affect other aspects of continued leadership. Early adopters may also learn from their own past experience. In our environment, leading jurisdictions learn how to effectively propose potential LOST rate increases to voters based on their own previous experiences. Similarly, citizen-voters may also learn from previous policies in their own communities. Taxpayers who have already grown accustomed to a 1 percent LOST may be more likely to accept a 2 percent LOST than citizens who have no previous experience with a LOST. In this way, early implementation can reinforce the expansion of a policy in the future.

Communities also learn from each other. Glick (2012) presents theoretical models of learning in a sequential decision making framework with multiple jurisdictions and uncertainty. He concludes that a relatively small group of actors can originate policy (i.e., the extensive margin) from which others can learn, creating a predictable diffusion process. In our setting, leaders may have better knowledge about how to implement LOST programs. In this way, early implementation can reinforce the acceptance of local sales tax rate increases in the future. Early leaders reinforce their knowledge base which peers and nonpeers may strategically mimic.

Strategies motivated by tax competition are also likely to be reinforcing. A main concern associated with increasing a LOST rate is a partial loss of the tax base (Burge and Rogers, 2011). Communities with retail agglomerations are sheltered from rate differentials due to positive agglomeration externalities. Small communities lacking major retail clusters are susceptible to rate differentials, and may be less inclined to set higher rates than other regional competitors.

The factors driving leadership (e.g., agglomerations, demand for public and retail goods, government capacity, and citizen learning) are likely to be reinforcing over time. Hence, we expect strategic leader-follower patterns identified in the early part of the panel to persist into the later stages of policy diffusion. Facilitated by a lengthy panel, our approach allows classification of jurisdictions *prior* to exploring potentially asymmetric policy reaction functions.

3. LOCAL OPTION SALES TAXES IN THE U.S.

Although local option sales taxes currently raise more own source revenue for local governments in the U.S. than any other policy, except the property tax (Brunori, 2007), they are a relatively recent phenomenon. The first U.S. experience with a retail sales tax involved a *national* sales tax enacted following World War I. Soon after the federal level sales tax was revoked, states began to implement sales tax programs. Shoup (1936) documents that 24 states as well as New York City had broad based ad valorem retail sales taxes in place as the nation was digging out of the ravages of the Great Depression. Sales tax programs did not spread (in any systematic way) to local governments until the 1960s and 1970s when many states passed legislation allowing local governments to tax sales occurring within their jurisdiction.

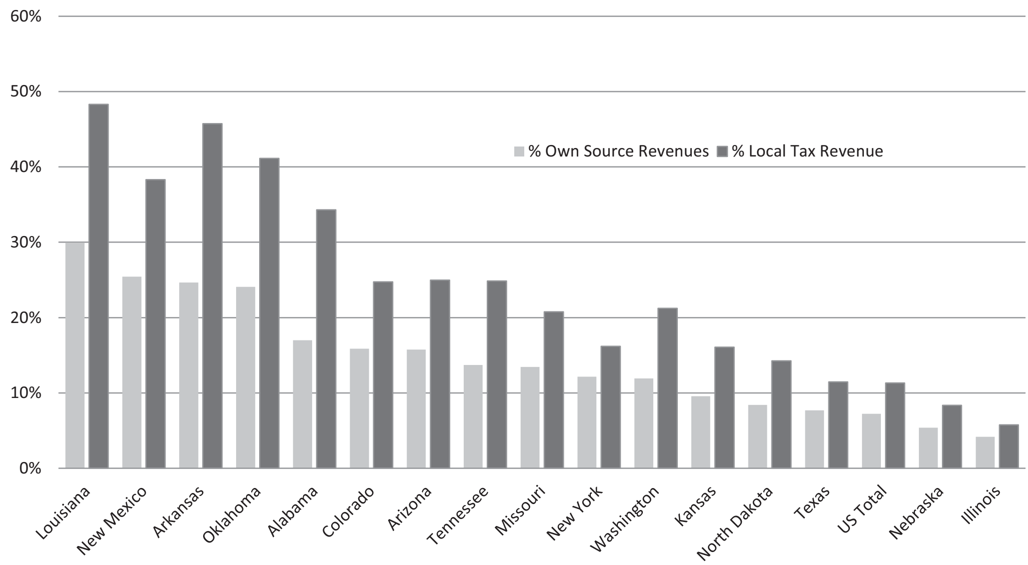
The diffusion of LOSTs has not been uniform across the U.S.[5] Delaware, Montana, New Hampshire, and Oregon have no sales taxes at all. Twelve states (Connecticut, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, Rhode Island, Vermont, and West Virginia) have a state sales tax levy, but no local taxes. Alaska authorizes local sales tax programs but has no state levy. Among the remaining states with sales taxes at both the state and local level, there is still considerable heterogeneity. Thirteen states (Florida, Idaho, Iowa, Minnesota, Nebraska, Nevada, North Carolina, Ohio, Pennsylvania, South Dakota, Virginia, Wisconsin, and Wyoming) authorize LOSTs at the municipal or county level, but not both. The 20 remaining states (Alabama, Arizona, Arkansas, California, Colorado, Georgia, Hawaii, Illinois, Kansas, Louisiana, Missouri, New Mexico, New York, North Dakota, Oklahoma, South Carolina, Tennessee, Texas, Utah, and Washington) use a three-tiered stacking rate structure (state + county + municipal).[6] Since multitiered environments create nuanced pressures over LOST policy choices, it is a natural choice for investigating leader-follower dynamics.

Local governments in many states have little control over the timing of LOST adoption or rate setting decisions. For example, Georgia, Hawaii, New Mexico, South Carolina, Tennessee, Texas, Utah, and Washington all use binding rate caps that result in nearly uniform rates at the cap. In Tennessee, municipalities can only implement a LOST if a gap is present between the county rate and the total rate cap of 2.75 percent. Since most counties are at the cap, cities are crowded out (Luna, Bruce, and Hawkins, 2007). In fact, only seven states (Alabama, Arizona, Colorado, Illinois, Kansas, North Dakota, and Oklahoma) have effectively unbounded LOST autonomy.[7] Figure 1 shows the percentage

[5]Readers interested in a more detailed overview of LOST policy in the U.S. should see Burge and Rogers (2011).

[6]While Georgia, Hawaii, and South Carolina are included, it is worth noting authorization at one local level is minimal in each case. For example, Atlanta levies the only general purpose municipal LOST in Georgia.

[7]To have effectively unbounded local autonomy one of two scenarios must exist. First, all local governments could be unconstrained (subject to voter approval) in setting rates. Second, one level is unconstrained while the other faces a rate cap that is largely nonbinding. See Mu and Rogers (2004) for additional discussion.



Source: U.S. Census, 2011 Annual Survey of State and Local Government Finances.

FIGURE 1: LOST Revenue Reliance: U.S. and States with County and Municipal LOSTS, Fiscal Year 2011.

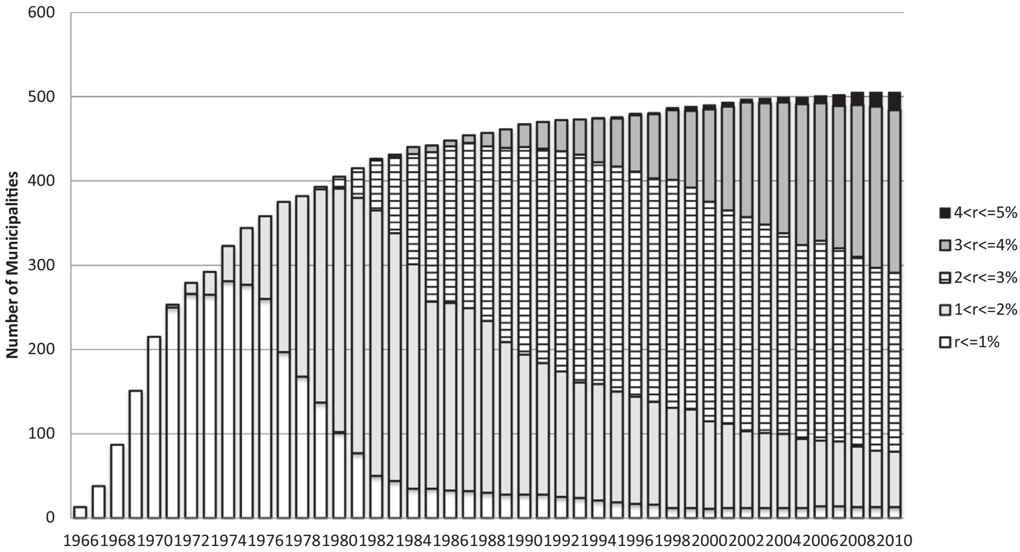
of local tax revenue coming from LOSTs in states where both municipalities and counties have at least some discretion over rates. For the majority of these states, including Oklahoma, LOST revenues are very important.

Policy leadership is most likely to be evident in scenarios exhibiting four characteristics: (1) local governments have autonomy regarding initial implementation, (2) local governments enjoy autonomy over initial and subsequent rate levels, (3) variation in the extensive (adoption) and intensive (rate levels) margins are meaningful, and (4) local governments rely on the tax for a significant portion of their own-source revenues. Oklahoma LOSTs meet all four conditions.

4. LOST POLICY DIFFUSION IN OKLAHOMA

Oklahoma municipalities were among the earliest adopters of local sales tax programs. Beginning in 1966, municipalities were authorized to enact LOSTs, subject to voter approval. The tax base is defined uniformly across municipalities and includes the majority of consumer retail sales, as well as business purchases of some nonretail items. We obtained histories of all municipal, county, and state sales tax rates and revenues from the Oklahoma Tax Commission. Our panel covers 1966 through 2010 and contains the entire population of the 506 municipalities that had programs in place by 2010.[8] The

[8]This also represents complete coverage of the municipalities that could have reasonably implemented programs, such that selection bias is not an issue in our analysis. While the U.S. Census Bureau lists a handful of towns that are not in our sample, these jurisdictions generally have fewer than 100 reported residents, little to no retail activity, and do not provide significant public services. Hence, we do not view these cases as viable taxing entities.



Source: Oklahoma Tax Commission.

FIGURE 2: Local Option Sales Tax Rates: Oklahoma Municipalities 1966–2010.

tax base for each municipality is not directly reported. Accordingly, we calculate the tax base using the following identity:

$$BASE_{i,t} = r_{i,t}/\tau_{i,t}, \quad (1)$$

where $r_{i,t}$ denotes total revenue and $\tau_{i,t}$ is the tax rate imposed by municipality i in year t.

Our regression analysis uses the tax rate from December. In cases where rates change within a year, a time-weighted rate is used in Equation (1). The weighted tax rate is calculated as

$$\tau_{i,t}\,(weighted) = tax\ rate_1 * month_1/12 + tax\ rate_2 * month_2/12, \quad (2)$$

where $month_1$ and $month_2$ are the number of months that each tax rate was in effect. While this adjustment may not fully reflect the seasonality of LOST revenues, it serves our application well given the small number of mid-year rate changes relative to the total number of observations.[9]

Figure 2 summarizes the timing of adoptions and subsequent rate increases. Adoptions were common in the late-1960s and early-1970s: by 1970 over 150 municipalities had programs. During this period, rates were uniformly 1 percent. By 1975, over 300 municipalities had LOSTs in place. While 1 percent remained the most commonly adopted rate during this period, higher rates began to surface in the mid-1970s. By 1980, nearly 400 municipalities had LOSTs and, for the first time, municipal LOST rates exceeding 1 percent were the most prominent. In the decades that followed, initial adoptions were infrequent and the heterogeneity in rate levels increased substantially.

[9]Furthermore, using a less than perfect weighting procedure would only bias later results to the extent that weighting errors were systematic in nature. We can think of no *a priori* reason why this would apply.

Recall that our goal is to use the data both to identify policy leaders, and to investigate how leadership may influence strategic tax policy interactions. To this end, we split our panel into two periods: 1966 to 1976 is the early period used to assign leaders. The early period captures the majority of initial adoptions and is of sufficient length for jurisdictions to display leadership by raising their rate above the prevailing 1 percent norm (i.e., reveal the intensive margin). The first LOST rates to exceeded 1 percent were implemented in 1971. For symmetry, we include the five-year period before and after 1971, so as to allow a similar period of adoption for the intensive and extensive margins. By 1976, nearly 100 municipalities levied rates above 1 percent.[10]

Both stages of our analysis respect the role of economic regions. We use the 11 Workforce Investment Regions (WIR) defined by the Oklahoma Department of Commerce (ODC). The WIR have several advantages. First, no county lies in multiple regions. This is important since county governments have LOST programs. In addition, the WIR designations have been stable over long periods of time, alleviating concerns about potential endogeneity (i.e., the possibility that choices regarding LOSTs are influenced by development patterns).[11] Finally, they are reasonably sized. With the exception of the northwest region (containing the panhandle), one could drive across any individual region in less than two hours.

5. CONSTRUCTING THE LI

In the first stage of our empirical procedure, we construct an index that reflects multiple aspects of leadership. This motivates the need for factor analysis.[12] We utilize five variables that are well suited to our selected environment. In general, any number of variables could be used subject to data availability. For our measures, positive/high values reflect leadership, while negative/low values reflect a lack thereof. Of the variables used to construct the index, two measure the extensive margin, two reflect the intensive margin, and the fifth is a hybrid of both. Recall the LI is constructed using only data from 1966 to 1976.

To reflect asymmetry in timing of adoption, we construct *First_in_state*, which equals one if a municipality adopted in 1966, and zero otherwise. As discussed previously, early adoption may be driven by greater administrative capacity, as well as factors likely to lower the costs and/or raise the benefits of adoption.[13] Although large cities adopted earlier on average, not all initial adopters were large, and not all large municipalities adopted in 1966. Additionally, Table 1 shows only 5 of the 11 regions contained a 1966 adoption. Tax mimicking and yardstick competition effects should dissipate with distance.

[10]Further exploration revealed the eventual leadership index values were robust to the choice of the cutoff year, as long as the cutoff was in the mid-1970s or later. In fact, a very high correlation exists between the index values (and designated leaders) we obtain using 1966–1976 and those obtained using the entire 45-year panel.

[11]The WIR definitions are defined by the 1998 Federal Workforce Investment Act, but are identical to a similar classification system from the 1982 Job Training Partnership Act. We spoke with ODC officials to see if the same system was in the 1973 Comprehensive Employment and Training Act, or the 1962 Manpower Development and Training Act. Although we could not confirm this, the ODC officials speculated that this was likely.

[12]Specifically, the first factor is selected as the index value. Factors are not rotated in our analysis. Unsurprisingly, the estimated index values are highly correlated with the simple summation of factor values. This is reassuring as it indicates that the index itself is fairly robust to the factor loadings of any individual factor.

[13]Readers interested in further discussion concerning LOST program adoption should see Burge and Piper (2012).

TABLE 1: Leadership Index (LI) Variables and Constructed Values (by Region)

Region	Jurisdictions (Leaders)	1st Adoption	LOST Mean	Frequency LOST ≥ 1	LI Mean	LI St. Dev.	LI Minimum	LI Maximum
Central	42 (7)	1966	0.59	0.024	1.22	1.06	0.14	3.31
Eastern	41 (4)	1966	0.55	0.610	1.04	1.29	−0.16	4.47
East Central	39 (1)	1967	0.42	0.231	0.98	1.02	0.16	5.63
North Central	55 (2)	1967	0.40	0.273	1.05	0.90	0.16	4.98
Northeast	52 (2)	1967	0.39	0.212	1.07	0.87	0.20	4.38
Northwest	29 (1)	1967	0.48	0.517	1.06	1.06	−0.05	4.13
Southern	52 (2)	1966	0.37	0.212	1.11	0.89	0.22	3.39
South Central	66 (4)	1966	0.43	0.576	0.99	1.32	−0.04	5.71
Southeast	50 (7)	1966	0.52	0.900	1.09	1.70	−0.30	6.74
Southwest	42 (3)	1968	0.44	0.691	1.11	1.18	−0.11	4.63
Tulsa	38 (4)	1967	0.64	1.342	1.11	1.66	−0.65	4.81
Total	**506 (37)**	**1966**	**0.47**	**0.494**	**1.07**	**1.20**	**−0.65**	**6.74**

Source: Oklahoma Tax Commission.

This dissipation may have been more intense in the 1960s compared with now since information flows more freely. Accordingly, we construct *First_in_region* to equal one if the municipality adopted in the year LOST programs first appeared in their region, and zero otherwise. LOSTs surfaced in the north central, east central, Tulsa, northeastern, and northwestern regions in 1967. The southwestern region first saw a LOST program in 1968.

Unlike *First_in_state* and *First_in_region*, the remaining variables reflect rate intensity. *Relative_intensity* is constructed as each municipality's mean LOST rate from 1966 to 1976, less the average mean LOST rate for their region.[14] Interestingly, the central region contained seven of the 13 1966 adopters, but soon fell short of the Tulsa region in terms of overall intensity. An important trait of this period is the dominance of LOST rates of 0 percent and 1 percent. Of the 5,566 observations (506 municipalities × 11 years), 3,213 (57.7 percent) are 0 percent and 2,103 (37.8 percent) are 1 percent. The remaining 250 cases (4.5 percent of the data) have rates of 2 percent. Hence, a rate of 2 percent represented leadership. We define the variable *Relative_above1* as the number of years a municipality had a 2 percent rate, minus the same count averaged over other jurisdictions in the region. Considerable variation in this measure across regions is reflected in the fifth column of Table 1. For example, during this period communities in the Tulsa region were over 50 times more likely to display rates of 2 percent than communities in the Central Region.

The final variable reflects the extensive and intensive margins by considering the rate charged at initial adoption. It should be more difficult to gain voter support for a LOST program if the proposed rate is relatively high. *Relative_adoptionrate* compares the regional median LOST rate in the year of adoption with each municipality's initial adoption rate. Municipalities adopting a rate higher than the current regional median are assigned a value of two. Adopters of rates less than or equal to the median are assigned a value of one. If initial LOST adoption took place after 1976, the community is assigned a value of zero. Although this variable loads significantly in our factor analysis, a reasonable criticism is that it replicates information conveyed by the other measures. In fact, *Relative_adoptionrate* is highly correlated with our early adoption measures since early adopters, by definition, adopt a rate above their regional average. However, this

[14]Tax rates of 0 enter the average for years where no program was in place.

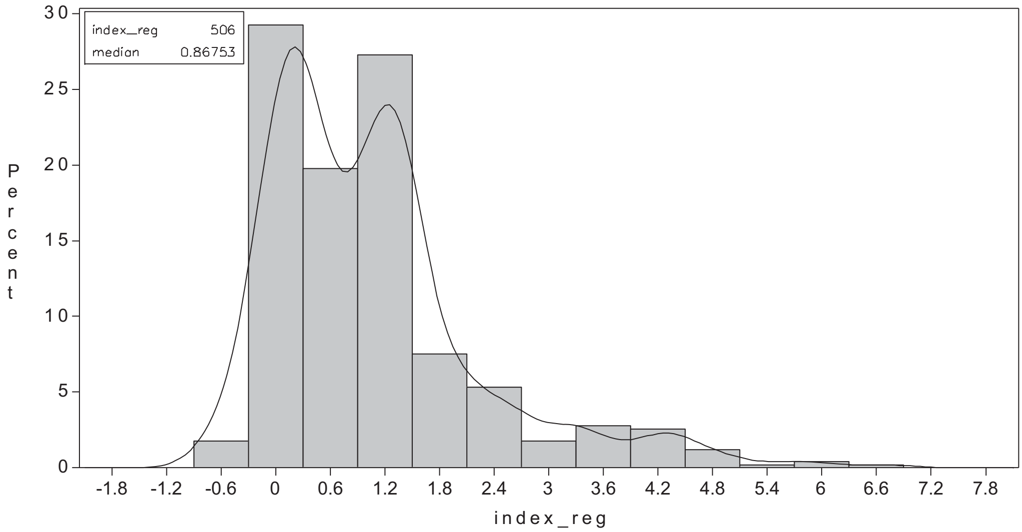


FIGURE 3: Kernel Density Function for the Leadership Index.

variable should display unique information in applications where tax rates at adoption display more variation than in our particular case. A final point worth noting is that, while regional leadership dynamics were well established by 1976, the intensity of regional LOST utilization continued to vary considerably over the rest of the sample. In 1976, the Tulsa region was highest, followed by the Southeast and then the East Central. By the end of the panel, the East Central region moved from the lowest to the highest in the group.

In our application, the outcome of the factor analysis is similar to taking the simple sum of the five variables. Accordingly, our index values are not particularly sensitive to the specification selected.[15] We find evidence that distinct groups exist within our data. The kernel density function shown in Figure 3 gives visual evidence regarding the distribution of leadership.

We define leaders to be those jurisdictions located in the distinctive hump in the right tail of the density function. We selected a cutoff value of 3.3: the density function reveals a local minimum just below that value. Thirty-seven municipalities lie above this cutoff while 469 fall below. The Central and Southeast regions have more leaders than the other regions (seven) and the Northwest and East Central regions contain only a single leader.[16]

[15]For example, we replaced *Relative_intensity*, *Relative_above1*, and *Relative_adoptionrate* with similar variables that ignored regions (i.e., made comparisons with state averages). The correlation between index values across the two approaches was 0.96 and the set of municipalities defined as leaders was nearly identical.

[16]Following the suggestion of a reviewer, we verified our results are not sensitive to the selected cutoff. Compared to alternative possibilities (e.g., 2.0, 2.5, 3.0, and 3.5), the value 3.3 led to fewer “close calls” (on either side) than any other choice. Also, using 3.3 gives all 11 regions at least one leader. If we use 3.5 instead, two regions have no classified leaders. On the other hand, if we use cutoffs like 2.5 or 2.0, the number of leaders expands exponentially.

6. EXPLORING VERTICAL, HORIZONTAL, AND ASYMMETRIC POLICY RESPONSES

Our second stage uses the 34 years from 1977 through 2010 to explore the determinants of municipal LOST rates. Following the literature (and our eventual results suggesting leaders and followers behave asymmetrically), we begin with three models that differ in terms of the sample of jurisdictions and the nature of tax diffusion channels considered:

$$\text{(3a)} \qquad Baseline: \tau_{i,r,c,t} = \beta_1 TO_{r,t} + \beta_3 TC_{i,c,t} + \beta_4 Y_t + \beta_5 X_i + e_{i,t},$$

$$\text{(3b)} \qquad Follower: \tau_{i,r,c,t} = \beta_1 TL_{r,t} + \beta_2 TOF_{r,t} + \beta_3 TC_{i,c,t} + \beta_4 Y_t + \beta_5 X_i + e_{i,t},$$

$$\text{(3c)} \qquad Leader: \tau_{i,r,c,t} = \beta_1 TOL_{r,t} + \beta_2 TF_{r,t} + \beta_3 TC_{i,c,t} + \beta_4 Y_t + \beta_5 X_i + e_{i,t},$$

where $\tau_{i,r,c,t}$ is the LOST rate in jurisdiction i, located in region r, and county c, at time t. The baseline model (3a) examines all 506 jurisdictions and ignores any potential asymmetries for leaders and followers. $TO_{r,t}$ is the population-weighted LOST average for all other municipalities in region r during time t. The follower model explores the rate setting behavior of the 469 jurisdictions we classify as followers, where $TL_{r,t}$ and $TOF_{r,t}$ are the populated-weighted LOST average for all the leaders and all of the other followers in the region, respectively. Similarly, the leader model investigates the rate setting behavior for the 37 leaders using the weighted average LOST for the other leaders ($TOL_{r,t}$) and all followers ($TF_{r,t}$) in the region. Following Gibbons and Overman (2012), we decided against using a spatial econometric approach.

Vertical spillovers are captured via $TC_{i,c,t}$ which reflects the LOST rate of the parent county of municipality i at time t. Unfortunately, many factors that could affect municipal LOST rates (e.g., income levels, employment) are unobservable at the annual level for municipalities. Accordingly, our variables are limited to time and area-specific fixed effects, a dummy indicating whether the jurisdiction had a recent rate increase, and border dummies.[17] Y_t is a vector of annual dummy variables that controls for factors commonly affecting rates in all municipalities for a given year. X_i is a vector of municipality dummy variables which control for unobserved time invariant factors that are unique to municipality i. The dummy variable for recent increases helps insulate our other coefficients from bias associated with the underlying cyclical nature of the rate setting process (i.e., communities are unlikely to propose current rate increases if they have increased rates in the recent past). We include dummies indicating whether the jurisdiction is in a county sharing a border with Texas, Kansas, and/or Arkansas, to capture recognized enhanced tax competition near state borders. Finally, to address the presence of heteroskedasticity, we cluster all estimated standard errors at the municipal level.[18]

Despite the advantages of using a long panel, theory offers no *a priori* stance regarding how to incorporate timing dynamics. In cross-sectional studies, the observed system of tax rates is generally acknowledged to be endogenous, motivating actions to mitigate endogeneity bias in the estimated regressions. In a panel data setting, it is possible to

[17] We thank an anonymous referee for a suggestion that led us to control for recent LOST rate increases in all our specifications. Estimates concerning horizontal and vertical tax competition are remarkably stable across various specifications of time used to construct this variable. We report results which include a variable that indicates if the municipality experienced a rate increase over any of the previous four annual transitions.

[18] Clustering errors at the regional level leads to slightly larger standard errors for most variables. However, all the effects we later discuss retain significance at conventional levels.

TABLE 2: Actual Leaders versus Random (Placebo) Leaders

Variable Mean	Full Sample	Actual Leaders	Placebo Leaders	Actual Followers	Placebo Followers
Initial adoption	1975	1967	1976	1976	1975
Tax base	$35.4 million	$334.0 million	$19.8 million	$11.9 million	$36.7 million
LOST rate	1.93	2.47	1.87	1.89	1.94
2000 population	5,138	42,594	3,277	2,183	5,285
LI index	1.07	4.23	0.81	0.82	1.09

Source: Oklahoma Tax Commission.

estimate the effect of *previous changes* in the rates of other jurisdictions on *current policy actions*. It is important to determine the appropriate number of lags to include in the model.

A natural starting point is with the first-difference of Equations (3a), (3b), and (3c). For example, the baseline estimate would be specified as:

$$\text{(4a)} \qquad \Delta\tau_{i,r,c,t} = \beta_1 \Delta TO_{r,t} + \beta_3 \Delta TC_{i,c,t} + \beta_4 Y_t + e_{i,t},$$

$$\text{(4b)} \qquad \Delta\tau_{i,r,c,t} = \beta_1 \Delta TL_{r,t} + \beta_2 \Delta TOF_{r,t} + \beta_3 \Delta TC_{i,c,t} + \beta_4 Y_t + e_{i,t},$$

$$\text{(4c)} \qquad \Delta\tau_{i,r,c,t} = \beta_1 \Delta TOL_{r,t} + \beta_2 TF_{r,t} + \beta_3 TC_{i,c,t} + \beta_4 Y_t + \beta_5 \mathrm{X}_i + e_{i,t},$$

Equations (4b) and (4c), the first-differences of (3b) and (3c), are analogous. X_{i} is now removed and the annual dummy variables represent year-to-year transitions. Using first-differenced data allows us to separate the effects of contemporaneous and prior changes in the tax variables. In this context, significant correlation with contemporaneous rate changes reveals the likelihood of simultaneity, whereas significant correlation with lagged rate changes suggests the presence of policy interactions (e.g., tax competition). A drawback of first-differencing is that it produces R-squared measures which are an order of magnitude smaller than models explaining rate levels.

We explored alternative estimates of Equations (4a), (4b), and (4c) to find the appropriate lag structure. The results of specification tests (Akaike's) can suggest different lag structures for tax variables that are otherwise expected to perform similarly. Fortunately, our preliminary explorations generated consistent results associated with the rate variables for leaders, followers, and parent counties. Lagged changes in the 1- to 3-year range were individually meaningful (i.e., t-statistics above 1) and of the expected signs. Longer lags produced point estimates near 0 and with random signs. Accordingly, we simplify matters by including the contemporaneous rate changes (meant to register correlation driven by simultaneity) and variables reflecting changes that occurred during the preceding three-year window.

To further motivate separating municipalities into leader and followers, we estimate a modification of (4a) that interacts our leader variable with the variables testing for horizontal and vertical spillovers. We find evidence that leaders react in different ways. As a robustness check, we estimate placebo versions of (4b) and (4c) using random classification rather than our leader designations.[19] Table 2 gives descriptive statistics for key measures, including our estimated LI values, for our full sample, our designated leaders and followers, and randomly selected placebo leaders and followers. As expected, our

[19]We thank anonymous reviewers for these suggestions. When selecting the 37 random (placebo) leaders, we required each region to have a leader. We did so to remain consistent with our original emphasis on the importance of leadership within economic regions. Our first randomized draw of 37 municipalities satisfied the requirement.

actual leaders and followers differ dramatically while the placebo leaders and followers display no clear differences.[20]

7. RESULTS

Table 3 contains the results of our first-differenced panel OLS regressions for the baseline model and its extension with leader interaction terms. Tables 4 and 5 respectively present the separated follower and leader specifications, each supplemented with placebo tests. Across all estimated models, the estimated coefficient on the dummy variable indicating own rate increases occurred during any of the previous four annual transitions consistently displays statistical significance. To simplify the discussion, we note this at the outset and focus on the main results of interest.

The baseline model from Table 3 suggests the nature of horizontal and vertical policy spillover differs significantly. Regarding horizontal spillovers, both contemporaneous and lagged changes are positively correlated with rate changes, although the contemporaneous effects are much stronger. That comovement dominates the lagged effects suggests municipalities may be responding to common shocks as opposed to causally influencing one another. Again, this model does not account for policy leadership and potential asymmetric reactions between leaders and followers, so we are not able to draw firm conclusions. However, even in this restricted setting, we see vertical spillovers display the opposite direction of effect and timing. Little correlation is present with contemporaneous changes in the rates of parent counties, but a decline in the likelihood of municipal rate increases emerges over the years that follow. While statistically significant, the magnitude of the vertical spillover is small compared to the horizontal spillover. We take this as initial evidence that higher county rates crowd out rate increases at the municipal level, and that horizontal tax competition plays an even more prominent role. Still, a relevant question is whether or not leaders and followers belong in the same model or, put another way, are they influenced by spillovers in the same way?

The second set of results in Table 3 highlights important differences between the leader and follower groups. The county rate interactions suggest leaders are similarly influenced by vertical spillovers. Leaders, however, have a higher overall likelihood of raising LOST rates and have dramatically different behavior regarding horizontal spillovers. Although only the coefficient on the lagged term achieves significance, both municipal interactions essentially remove the baseline effect.

Mirroring the baseline model in terms of vertical spillover effects, the results presented in Table 4 suggests that followers do not concurrently react to county rate increases, but are less likely to raise their own rates during the next three years following a county rate increase. In contrast to the baseline results, however, the nuanced nature of horizontal tax competition in this setting is revealed. While reactions to rate changes of other followers stays largely the same (i.e., positive in direction and with a greater emphasis on comovement), followers are more likely to raise rates over the next three years following, but not in the same year, as rate changes by regional leaders. Hence, the timing sequence now mirrors the pattern from the county rate variable, but with the opposite directional effect, as would be expected. For comparison, we also used randomly selected (placebo) leader and follower designations. As expected, vertical spillovers channels are unaffected since these influence leaders and followers alike. In contrast, the nature of horizontal effects reverts back toward the patterns seen in the naïve model.

[20]The seemingly relevant difference between the tax base level is fairly arbitrary and comes down to how Oklahoma City and Tulsa are classified by the randomization. Median values display more consistency.

TABLE 3: Panel OLS Regression Results (4a): Full Sample Naïve Model and Leader Interactions

Dependent Variable: Change in Tax Rate (Δ τ)

	Coefficient	Robust Standard Error	*t*-Stat	*P*-Value
Naïve model				
Change in other regional municipalities (contemporaneous)	0.1760	0.0565	3.11**	0.002
Change in other regional municipalities (3-year lagged)	0.0583	0.0269	2.16*	0.031
Change in parent county rate (contemporaneous)	−0.0040	0.0089	−0.45	0.650
Change in parent county rate (3-year lagged)	−0.0172	0.0052	−3.27**	0.001
Recent (own) increase	−0.0896	0.0042	−21.31**	0.000
Kansas border	−0.0102	0.0038	−2.65**	0.008
Texas border	−0.0132	0.0038	−3.50**	0.001
Arkansas border	−0.0076	0.0043	−1.78	0.076
Number of Observations: 17,204 (506 jurisdictions, 34 years)	Joint *F*-statistic: 18.25		*R*-squared: 0.03	
With leader interactions	Coefficient	Robust	*t*-Stat	*P*-Value
Change in other regional municipalities (contemporaneous)	0.1850	0.0595	3.11**	0.002
Interaction with leader designation	−0.1526	0.1255	−1.22	0.225
Change in other regional municipalities (3-year lagged)	0.0723	0.0278	2.60**	0.010
Interaction with leader designation	−0.2025	0.0430	−4.71**	0.000
Change in parent county rate (contemporaneous)	−0.0025	0.0091	−0.27	0.784
Interaction with leader designation	−0.0242	0.0370	−0.65	0.514
Change in parent county rate (3-year lagged)	−0.0165	0.0055	−2.99**	0.003
Interaction with leader designation	−0.0064	0.0133	−0.48	0.633
Leader dummy variable	0.0478	0.0142	3.36**	0.001
Recent (own) increase	−0.0902	0.0042	−21.30**	0.000
Kansas border	−0.0096	0.0032	−2.95**	0.003
Texas border	−0.0090	0.0032	−2.83**	0.005
Arkansas border	−0.0040	0.0033	−1.19	0.233
Number of observations: 17,204 (506 jurisdictions, 34 years)	Joint *F*-statistic: 17.14		*R*-squared: 0.03	

Notes: Standard errors are clustered at the municipal level. Year dummies included in estimation but not reported. (Full results available upon request.) *Significant at the 5 percent level. **Significant at the 1 percent level.

TABLE 4: Panel OLS Regression Results (4b): Follower Sample with Actual and Placebo LI Values

Dependent Variable: Change in Tax Rate (Δ τ)

	Coefficient	Robust Standard Error	*t*-Stat	*P*-Value
Estimated with actual LI values				
Change in regional leaders (contemporaneous)	−0.0014	0.0110	−0.12	0.901
Change in regional leaders (3-year lagged)	0.0118	0.0053	2.23*	0.026
Change in other regional followers (contemporaneous)	0.0968	0.0304	3.19**	0.002
Change in other regional followers (3-year lagged)	0.0213	0.0190	1.12	0.263
Change in parent county rate (contemporaneous)	−0.0029	0.0092	−0.32	0.751
Change in parent county rate (3-year lagged)	−0.0151	0.0056	−2.73**	0.007
Recent (own) increase	−0.0896	0.0044	−20.24**	0.000
Kansas border	−0.0095	0.0042	−2.28*	0.023
Texas border	−0.0143	0.0039	−3.64**	0.000
Arkansas border	−0.0075	0.0045	−1.65	0.100
Number of observations: 15,964 (469 jurisdictions, 34-years)	Joint *F*-statistic: 16.40		*R*-squared: 0.03	
Estimated with placebo LI values				
Change in regional leaders (contemporaneous)	0.0190	0.0127	1.50	0.134
Change in regional leaders (3-year lagged)	−0.0010	0.0054	−0.19	0.853
Change in other regional followers (contemporaneous)	0.0463	0.0231	2.00*	0.046
Change in other regional followers (3-year lagged)	0.0161	0.0158	1.02	0.310
Change in parent county rate (contemporaneous)	−0.0011	0.0094	−0.12	0.904
Change in parent county rate (3-year lagged)	−0.0157	0.0054	−2.91**	0.004
Recent (own) increase	−0.0897	0.0044	−20.44**	0.000
Kansas border	−0.0094	0.0042	−2.26*	0.024
Texas border	−0.0147	0.0038	−3.88**	0.000
Arkansas border	−0.0086	0.0046	−1.87	0.062
Number of observations: 15,964 (469 jurisdictions, 34-years)	Joint *F*-statistic: 16.72		*R*-squared: 0.03	

Notes: Standard errors are clustered at the municipal level. Year dummies included in estimation but not reported. (Full results available upon request.) *Significant at the 5 percent level. **Significant at the 1 percent level.

TABLE 5: Panel OLS Regression Results (4c): Leader Sample with Actual and Placebo LI Values

Dependent Variable: Change in Tax Rate ($\Delta\ \tau$)

	Coefficient	Robust Standard Error	t-Stat	P-Value
Estimated with actual LI values				
Change in other regional leaders (contemporaneous)	0.0907	0.0428	2.12*	0.041
Change in other regional leaders (3-year lagged)	0.0001	0.0156	0.00	0.997
Change in regional followers (contemporaneous)	0.0741	0.0733	1.01	0.318
Change in regional followers (3-year lagged)	−0.0651	0.0439	−1.48	0.147
Change in parent county (contemporaneous)	−0.0139	0.0392	−0.35	0.725
Change in parent county (3-year lagged)	−0.0284	0.0144	−1.97	0.057
Recent (own) increase	−0.0844	0.0141	−5.99**	0.000
Kansas border	−0.0043	0.0081	−0.53	0.600
Texas border	−0.0304	0.0095	−3.20**	0.003
Arkansas border	−0.0327	0.0087	−3.75**	0.001
Number of observations: 1,258 (37 jurisdictions, 34-years)	Joint F-statistic: 136.77		R-squared: 0.06	
Estimated with placebo LI values				
Change in other regional leaders (contemporaneous)	−0.0750	0.0509	−1.47	0.149
Change in other regional leaders (3-year lagged)	0.0040	0.0196	0.20	0.839
Change in regional followers (contemporaneous)	0.0040	0.0865	0.05	0.963
Change in regional followers (3-year lagged)	−0.0272	0.0704	−0.39	0.701
Change in parent county (contemporaneous)	−0.0270	0.0259	−1.04	0.305
Change in parent county (3-year lagged)	−0.0262	0.0246	−1.07	0.293
Recent (own) increase	−0.0810	0.0145	−5.59**	0.000
Kansas border	−0.0246	0.0104	−2.37*	0.023
Texas border (dropped, insufficient variation)				
Arkansas border	0.0004	0.0098	0.04	0.967
Number of observations: 1,258 (37 jurisdictions, 34-years)	Joint F-statistic: 128.91		R-squared: 0.04	

Notes: Standard errors are clustered at the municipal level. Year dummies included in estimation but not reported. (Full results available upon request.) *Significant at the 5 percent level. **Significant at the 1 percent level.

The results shown in Table 5 suggest leaders behave quite differently. First, they seem to have less influence over one another than they exert over followers. The coefficient for the contemporaneous tax rate changes of other regional leaders is positive and significant, but the three-year lag of the same variable is not correlated with current rate setting decisions. In fact, leaders seem largely unaffected by most of the tax variables included in the model. The predicted reaction to lagged changes of the parent county is significant at the 10 percent level, and there is still evidence that enhanced tax competition still occurs at the borders with Texas and Arkansas. For consistency, we show estimates using placebo leaders in the models. The placebo leader group is still small and primarily contains jurisdictions classified as followers using our LI approach.

Beyond our main variables of interest, the annual transition dummies reveal the influence of vertical tax competition.[21] The observed pattern, in terms of magnitude, sign, and significance or lack thereof, stems from omitting the first transition as the reference group. In the follower models, coefficients for the early transitions are small and of random sign. This ends with the 1983–1984 transition, when the coefficients become consistently negative and significant. Two factors relating to vertical tax competition are relevant. First, counties in Oklahoma were first able to implement LOST programs in 1984. Second, the state rate was 2 percent between 1936 and 1983, increased to 3 percent in 1984, and then to 3.25 percent in 1985. Thus, it seems that followers responded to tax increases at higher levels by raising their tax rates less frequently. However, we do not observe similar responses in the leader model, where coefficients remain insignificant and of random sign throughout the 1980s, and in fact, for most of the entire sample. This provides additional evidence that leaders were less influenced by vertical tax competition than followers.

8. CONCLUSIONS, LIMITATIONS, AND EXTENSIONS

This paper utilizes a 45-year panel of municipal LOSTs in Oklahoma in an environment where municipal and county governments tax the same retail base and where LOST revenues play a prominent role in both levels of local governance. We first designate policy leaders and followers, and then investigate the extent to which horizontal and vertical spillovers diverge between the two groups. Our approach adds to an emerging branch of the tax competition literature focusing on endogenous leadership, and more broadly, to the policy diffusion literature that explores asymmetric leader–follower dynamics. By developing a data-driven LI, our study is the first to use early policy decisions to endogenously label jurisdictions as leaders and followers. This approach could be useful in a wide array of other applications.

We find evidence of horizontal and vertical policy spillover. Accounting for leader–follower dynamics offers an improved understanding of the nature of policy diffusion. Our results suggest designated leaders played an important role in determining the overall policy dynamics seen in our investigated setting. Followers, who constitute roughly 93 percent of our sample, were less likely to raise LOST rates if their parent county recently had a rate increase, but were more likely to do so if leaders in their region had recently raised rates. On the other hand, followers do not seem to respond to LOST changes from other followers. Leaders seem less responsive to pressures of horizontal tax competition. Except for along state borders, we see little evidence that our designated leaders react to the policy changes of other leaders or to followers in their economic region. However,

[21] To save space, we omit the transition dummies from our presented results. Full results are available upon request.

we still find weak evidence that suggests vertical competition still plays a significant, although diminished, role.

Our analysis is not without caveats. First, the role of unobserved common shocks in not considered. It is possible that leaders respond to common shocks more rapidly than followers, causing observed spillovers to reflect this differential rather than meaningful tax competition. Second, we do not establish a strong causal link between leaders' actions and followers' reactions, but rather document correlations that are consistent with leaders playing an expanded role in affecting policy diffusion. We leave these extensions for future work.

Our approach offers a useful strategy for investigating policy diffusion in a broad range of scenarios where policy choices are decentralized and vertical and horizontal competition is evident. For example, social policy innovations such as charter schools, public health projects, electronic medical records, local education programs, and environmental standards/regulations are all likely to display nuanced leader–follower dynamics.

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