Fiscal Competition and Reality: A Time Series Approach

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Working Paper 98-19
September 1998

Abstract: Strategic interjurisdictional behavior and the interaction over time of the mean and dispersion of average tax rates across states are analyzed in a vector autoregression model. Variance decompositions reveal that fiscal competition explains roughly one-third of the time variation of state and local taxes. Impulse response functions identify the type of fiscal competition and the characteristics of leaders and followers. Local tax dynamics agree with Wildasin's (1988) results on expenditure competition with significant short- and medium-run effects but insignificant long-run effects. State tax dynamics conform to tax export competition with significant effects occurring over a relatively short time.

JEL classification: H70, C32, C72

Key words: intergovernmental competition, state and local taxes, time series methods

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The author is grateful for valuable comments and suggestions from Gerry Carlino, Ted Crone, Chris Mayer, D'Ann Petersen, Lori Taylor, Bill Testa, Dick Voith, Ping Wang, David Wildasin, and Mark Wynne, as well as from participants at the Federal Reserve's 1995 Regional System Meeting in Philadelphia and the 1996 Western Economics Association Meetings in San Francisco. The views expressed here are those of the author and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System. Any remaining errors are the author's responsibility.

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1. Introduction

How do governments determine fiscal policy taking interjurisdictional mobility of consumption and factors of production into account? This question lies at the heart of the state and local public finance literature. One aspect that has received increasing attention among academics and the general public is the competition between governments for interjurisdictionally mobile sources of tax revenues.[1] The fiscal competition literature, starting with Oates (1972) and followed by others, has analyzed tax and expenditure competition and tax exporting by governments in a variety of settings and discussed a wide range of policy proposals.[2] Most recently, theoretical work has turned from models with governments that do not recognize the interdependency among jurisdictions when setting policy to models where governments are aware of the dependency and react to the actions of others.[3]

The empirical research on fiscal competition has accumulated evidence of the economic effects of differential fiscal policies in a world of mobility but little hard evidence of what drives differentials.[4] More importantly, there is little evidence and no direct tests to show that inter-

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[1]For a general overview of the public debate on fiscal competition see the Federal Reserve Bank of Minneapolis' "Economic War of the States" website.

[2]The literature has explored the implications of different assumptions on mobility and available policy instruments and different behavioral assumptions. See also Arnott and Grieson (1981), Beck (1983), Gordon (1983), Wilson (1985, 1986), and Zodrow and Mieszkowski (1986) for early work in this area.

[3] This work has emphasized strategic interactions by governments in static models, as in Mintz and Tulkens (1986), Wildasin (1988), deCrombrugghe and Tulkens (1990), and even in a dynamic setting, as in Coates (1993). Related papers with a cross-country emphasis include Persson and Tabellini (1992) and Kanbur and Keen (1993).

[4]Inman and Rubinfeld (1996) provide a useful survey of the empirical literature. Generally, the findings are that factors and consumption are mobile and responsive to differential fiscal policies especially tax differentials, but whether or not competition is the source of the differen-

jurisdictional relations are competitive and what type of competition dominates.[5] Knowledge of the extent and type of fiscal competition is important for distinguishing what models are most applicable to the real world and for resolving positive and normative issues. First, knowing the extent of government competition sheds light on the constraints on policy choices and to what extent governments can pursue divergent policies. Not only does this have implications on whether fiscal policies will converge over time, it also has implications for the growth of government. For instance, tax competition for mobile resources tends to lead to lower taxes and constrains governments' Leviathan tendencies (Brennan and Buchanan, 1980), while expenditure competition may under some circumstances lead to higher taxes as states try to offer more or better services to attract mobile businesses and households. Second, policy recommendations may depend on the type of competition and the strategic environment. For instance, tax competition, which tends to lead to inefficiently low taxes, calls for different corrective measures than tax exporting, which tends to lead to inefficiently high taxes as governments try to shift tax payments onto non-residents. Also, the extent to which governments recognize interdependencies and act strategically affects the recommendations. In some instances, competition by encouraging convergence may reduce the need for externally imposed harmonization of policies or differential policies.

To answer to what extent fiscal competition matters and what types of competition

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tials is left open. Oates (1985) analyzes the effect of the degree of centralization of the public sector on the size of government tax revenues using static measures of competition, namely the number of jurisdictions and fiscal centralization ratios, but rejects a systematic relationship.

[5]A few papers explore this informally. For example, McGuire (1986) and Fisher (1991) relate tax differentials to fiscal competition. Also, Breton (1991), Chubb (1991) and Shannon (1991) discuss evidence that interjurisdictional relations are competitive.

dominate for state and local governments, I analyze movements over time of the cross-sectional distribution of average tax rates. Systematic movements of the first two moments of this distribution will to some extent reflect the strategic interactions of governments. When a government changes its effective tax rates, this sets off a sequence of reactions and counteractions by other governments most affected by prior moves. The idea, elaborated on more fully below, is that the various forms of competition lead to distinct sequences of tax rate changes and thus to characteristic dynamic interactions between the mean and dispersion of the distribution of average tax rates. For instance, with tax competition average tax rates fall initially, but dispersion rises or falls depending on whether the initiating state has above or below average tax rates. If states tend to match each other's tax cuts - a result for Nash equilibria in only the simplest static models (Mintz and Tulkens, 1986) - the mean and dispersion of average tax rates should fall over time. However, if some states choose not to match tax cuts but raise tax rates to compensate for revenues lost to other states, the mean may rise for some time periods. For tax export competition, the dynamics of the mean and dispersion of tax rates should be similar except that tax rates rise. Finally, when governments match each other's moves, expenditure competition should have similar effects on mean tax rates and their dispersion as tax export competition. However, Wildasin (1988) has shown that states may not match each other's expenditure and tax increases in Nash equilibrium, choosing instead to cut taxes.

The preceding arguments suggest that estimating a simple vector autoregression (VAR) model using the time series of the mean and dispersion can shed light on strategic interjurisdictional interactions. The VAR model can be used to identify strategic taxation behavior by distinguishing between competition shocks and aggregate shocks. In particular, shocks to an appropriately defined measure of dispersion can be interpreted as a break-away move by one jurisdiction or a competition shock. Then the strength of the strategic response can be measured by a variance decomposition or how much of the variation in the tax rate averaged across states is due to the competition shock. Furthermore, the shape of the estimated impulse response functions, or dynamic multipliers, generated by the VAR are used to identify the particular form of fiscal competition as well as leaders and followers, where error bands can be used to determine how close the data are to a non-strategic competitive model.

The second and third sections of this paper argue that by itself dispersion has nothing to say about fiscal competition and that looking at contemporaneous movements of mean and dispersion might also be insufficient. The fourth section of the paper, after discussing identification and specification issues in VAR models, shows that choice of a suitable measure of dispersion implies a natural ordering and an identification of shocks as either competitiveness shocks or aggregate tax shocks. With this interpretation, the fifth section presents the empirical results. Briefly, the findings are that competition on average explains roughly one third of the time variation of state and local tax rates: less so for state taxation (averaging 28 percent over a horizon of twelve years) and more so for local taxation (averaging 37 percent). State tax dynamics are consistent with tax export competition with significant effects occurring in a relatively short period of time. Local tax dynamics are consistent with Wildasin’s (1988) results on expenditure competition with significant short and medium run effects. The empirical analysis suggests that states with average tax rates that are above average dominate state tax rate dynamics and tend to trigger the initial competitive impulse for both local and state taxes, while states with low local average tax rates are driven by expenditure competition to further lower tax rates. Finally, the concluding section draws implications from the results and discusses potentially fruitful areas for research.

2. Theoretical and Empirical Background

Inman and Rubinfeld (1996) provide a conceptual framework based on Gordon (1983) to show what inefficiencies arise due to the decentralization of fiscal policymaking. They identify two opposing forces for government interaction: tax exporting and tax competition. Tax exporting arises when governments overuse taxes that shift burdens onto non-residents relative to other taxes. Thus, taxes will be higher the greater the fraction of non-resident consumption or non-resident factor employment in the jurisdiction. By contrast, tax competition arises when governments undertax activities for fear that taxed factors or consumption will migrate after a tax increase, thus shifting burdens onto residents. Their scoring of the evidence suggests that tax exporting is likely to be important for consumption taxes and less important for factor taxes, while tax competition is more likely to be important for factor taxes and consumption taxes. Because state taxes mainly tax income and consumption while local taxes are more capital taxes than anything else, this suggests that local taxation is likely to be dominated by tax competition and state taxation is up in the air. However, this neglects the fact that state taxes can be deducted from federal taxes which is another potential source of tax competition (Metcalf, 1993). Thus, there is one more argument that tax exporting may dominate state taxation. Another force underlying government interactions that is not addressed by Inman and Rubinfeld is expenditure competition where governments strategically choose expenditures on services that may also provide differential benefits to residents and non-residents apart from the taxes used for financing.

In non-strategic competitive models with a large number of jurisdictions where governments take each others behavior as given, tax competition leads to inefficiently low tax rates and tax exporting to rates that are too high. However, in recent strategic models that have examined governments' reactions to other governments' policy moves, matters are not that clear. An important issue in all of these models is whether tax response functions are increasing or decreasing, that is, whether governments match each other's moves or not. In simple static Nash models of tax competition, one frequently encounters increasing reaction functions that lead to matching behavior with tax rates that are too low for tax competition and too high for tax exporting. However, as Mintz and Tulkens (1986) first show, increasing reaction functions are not a general property of strategic taxation models when public expenditures are valued by agents. Also, Wildasin (1988) shows that even if expenditures are not valued but are used strategically by identical jurisdictions, then expenditure competition will result in non-matching behavior in tax rates in an environment where tax competition leads to matching behavior.[6] Finally, Kanbur and Keen (1993) show that whether or not jurisdictions match each others behavior also depends critically on differences in size. Thus, while simple static models allow sharp inferences about movements in tax rates, more general models do not.

Interjurisdictional competition has been perceived as a sort of centripetal force for regions, and various measures of dispersion have been used to infer the strength of competition. For instance, McGuire (1986) identifies a narrowing of various measures of tax differentials as evidence for increasing competition. These tax differentials are measured using ranges or standard deviations. McGuire distinguishes between different tax sources implicitly recognizing

[6]Wildasin (1991) shows that whether tax rates or expenditures are the dominant strategic variable depends crucially on the structure of the underlying environment.

different strategic processes may be at work. Fisher (1991) looks at the coefficient of variation of state and local taxes combined for a select number of years to answer whether competition has been increasing over time by comparing the dispersion of tax rates. Both studies do not discern a pattern, partly because the measures used may be defined too narrowly by McGuire or too broadly by Fisher and partly because of the time frame. While both studies are aware that competition among governments is not a static concept but a dynamic process where strategic actions provoke counteractions, only Fisher compares dispersion over different time periods. The problem is that the particular time periods chosen may obscure dynamics in intervening periods. Thus, it is better to analyze a time series that gives a complete sequence of policy moves.[7] Also, while these studies look at dispersion in isolation, no effort is made to associate changes of dispersion to other variables and thus tie them to a particular theory of competition.

While the ideas of fiscal competition as a centripetal force for tax rates is tempting, it does not stand up to closer inspection. The problem is that dispersion by itself measures the strength of fiscal competition for only the simplest of models.[8] At the very least the interaction of the mean of tax rates and dispersion must be studied in order to identify the type of fiscal competition. However, even this may be insufficient, as can be easily shown. Literally, tax differentials narrow

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[7] One problem is that it is difficult to project the results of static Nash models onto dynamic framework. As Coates (1993) shows in a repeated game framework, static models do not capture transition effects and ignore savings effects. While interjurisdictional competition has yet to be analyzed in a more general dynamic game-theoretic setting, one can loosely interpret simultaneous moves in timeless static models as sequential moves by leaders and followers where a slow legislative process impedes immediate responses.

[8] Another problem not considered here is that tax differentials arise not only from strategic interactions. The source of tax differentials may be internal, arising from strategic interactions or other government objectives, or they could be externally motivated. For example, both differential and aggregate federal policies may be driving dispersion.

and dispersion falls when there is matching behavior among low tax rate jurisdictions who raise their rates or among high tax rate jurisdictions who lower theirs. Alternatively, dispersion also falls when reaction functions are decreasing or when below-average tax rate jurisdictions raise their taxes at the same time above-average jurisdictions lower theirs. All other combinations, such as low tax jurisdictions lowering tax rates either among themselves or at the same time high tax areas raise rates, have dispersion rising. Thus, dispersion by itself does not reflect fiscal competition without other information about governments' strategic objectives. While co-movements of the mean and dispersion of tax rates are more revealing, there still might be insufficient information about the type of strategic competition.

To see that the covariance between mean and dispersion may not be sufficient to identify the strategic interactions of governments, it is useful to distinguish among four possible cases of mean and dispersion co-movements, as provided in Table 1. Dispersion and the mean move in the same direction if the impulse is from a state that has a tax rate that is higher than average. In case *A*, if the state lowers its tax rate, the mean and dispersion will fall. Alternatively, in case *B*, if the state raises tax rates, both series rise. Thus, both series will tend to be positively correlated if high tax states are the main movers. On the other hand, the mean and dispersion will move in opposite directions (negative correlation) if the impulse is from a state with tax rates below average. In case *C*, when such a state lowers its tax rate, dispersion will tend to rise and the mean will fall, while case *D* occurs when the state raises its tax rate.

Pure tax competition where followers match leaders suggests a sequence of cases *A* and *C*. First, assume that competition is led by a low tax state as in case *C*. Further movements of dispersion and the mean depend on who the followers are. When only low tax states follow, another case *C*, dispersion and the mean continue to fall over time and that both series are non-stationary. Alternatively, if high tax states follow, case *A* follows *C* and dispersion will tend to rise at the same time that the mean falls. While the mean still is non-stationary, dispersion may be stationary or not depending on whether it reverts back to its original position rather than undershooting or overshooting. When competition is initiated by high tax states, as in case *A*, non-stationarity of the dispersion series will depend on whether case *A* is followed more by case *A* than case *C*.[9] Alternatively, sequences of cases *B* and *D* suggest either pure expenditure or tax export competition where agents match each others moves.

However, the interpretation of mean-dispersion sequences is more complicated when cases *A* and *C* are mixed in with *B* and *D*. In this case one has to determine whether or why there was non-matching behavior by states. For instance, such states may have been trying to offset revenue losses because resources were competed away. Or else, there may have been expenditure competition *à la* Wildasin (1988). Thus, sequences of contemporaneous mean-dispersion movements and their overall correlation, although suggestive, can be less than clear-cut especially when the sequences exhibit a mixture of matching and non-matching behavior. As the next section makes clear, the data are subject to the same problems of interpretation. However, vector autoregression methods are well suited for pinning down competitive tax dynamics between states, based on a clear distinction between initial shocks and subsequent movements.

3. Description of the Data

All data are taken from DRI-McGraw Hill. The series are annual and the period covered

[9] While stationarity of the series usually does not help in distinguishing between cases, the issue is relevant for the time series analysis below.

runs from 1961 to 1992. Because the data are readily available, comparable across states, and easily interpreted, this study looks at the cross-sectional distribution of states' average tax rates, or ATRs, over time. ATRs are defined as the ratio of nominal tax revenues and nominal state personal income where ATR(L) consists of state revenues from local taxes and ATR(S) contains state revenues from state taxes. State and local taxes are considered separately, because different mechanisms drive taxes at state and local levels and aggregation would just confuse what are essentially separate dynamics. While marginal tax rates are the appropriate measure, they are hard to get and estimation methods would lose valuable time series information (Becsi, 1996). Also, one could argue that if strategic interactions matter, then they should be picked up in the state or local ATRs, even allowing for the fact that they are defined more broadly than the narrow tax bases commonly found in theoretical models of fiscal competition.

Before discussing the co-movements of mean and dispersion, some words about the particular measures used are in order. The dispersion measure used in this study is the log variance of average tax rates, or $LV() = \sum_i s^i\left[\ln ATR^i() + \ln E()\right]$, where s^i is the state's population share and the cross-sectional average of ATRs is defined by $E() = \sum_i s^i ATR^i()$. The choice of the log variance has been popular in the growth convergence literature (Barro and Sala-I-Martin, 1995), but may be overly sensitive to particular parts of the distribution (Cowell, 1995). More importantly for identifying the vector autoregression model below, is that LV is immune to equiproportional increases in population and tax rates. This property is important for distinguishing between different sources of shocks that affect mean and dispersion differently and thus to identify different types of fiscal competition.

Figures 1 and 2 look at the state and local dynamics separately. The mean and dispersion of state ATRs is depicted in Figure 1. The mean and dispersion measures have a negative correlation of -.97 (0.00) over the whole sample period, where the p-value is in parentheses. Consistent with competition between states, dispersion is falling throughout the sample period. However, the average series is trending upward, suggesting that not tax competition but rather pure expenditure competition, tax exporting, or some other factors are driving ATRs. Cases associated with tax competition, *C* and *A*, appear only during 1978 to 1982 and from 1987 onward; however, all other intervals are mainly case *D* with a few *B* thrown in. Overall, tax competition does not appear too significant a factor, but expenditure competition or tax exporting could explain the series. A literal interpretation of the mean-dispersion co-movements suggests that prior to 1972, low tax rate states raised ATRs, actions that were subsequently matched by high ATR states and more tax hikes by low tax states. High ATR states slightly lowered ATRs during 1972 to 1982, but low ATR states did not match these moves in 1982 to 1988, rather they increased ATRs (either to increase spending or to offset their own revenue losses). Finally, from 1989 onward, high ATR states lowered their ATRs and did not match previous moves. While the particulars are open to interpretation, it can be safely inferred that overall the sample period was characterized by expenditure competition or tax exporting.

In contrast to the ATR(S) series in Figure 1, dispersion of ATR(L) in Figure 2 shows a downward trend only from 1978 onward while the mean of local ATRs is falling prior to 1968 and during 1972 to 1981. The period prior to 1968 and the period from 1972 to 1981 both appear consistent with tax competition with case *C* trading places with *A*. However, after 1981, the average rises as dispersion continues to fall, case *D*. There are two possible explanations that interpret mean-dispersion movements literally: either a round of expenditure competition was triggered as local governments competed by, for instance, upgrading their public schools, or, low ATR states may have chosen not to match tax rate cuts by states with large ATRs. The overall correlation coefficient is positive and small but significantly different from zero, or .26 (0.016).

In sum, while different elements of the fiscal competition dynamics appear in places, the pieces do not fit together well and the overall picture is not too conclusive. The dynamics of the local measures suggests that pure tax competition has mattered especially from 1972 to 1981. On the other hand, tax competition appears to have little to do with the state measures, but expenditure competition and tax exporting seem plausible. Part of the reason why tax competition does not seem to be too important is because this discussion has tried to interpret sequences of contemporaneous mean and dispersion movements. More generally, the lagged effects of competitive impulses should also be considered. A VAR model is an efficient way of summarizing more general dynamic interactions.

4. The Vector Autoregression Model

The central questions of this paper are how important is fiscal competition and what form does it take? To answer these questions, I estimate a simple bivariate vector autoregression (VAR) model that has the following structure:

$$\boldsymbol{y}_t = \boldsymbol{c} + \sum_{i=1}^{p} \boldsymbol{\Phi}_i \boldsymbol{y}_{t\ i} + \boldsymbol{\epsilon}_t$$

where y_t is a (2×1) vector, c is a (2×1) vector of constants, $\boldsymbol{\Phi}_i$ is a (2×2) matrix of coefficients and $\boldsymbol{\epsilon}_t$ is a (2×1) vector of disturbances or shocks. For simplicity, I set the lag length p equal to two years and let $y_t = [LV_t(), \ln E_t()]$. This specification is not innocuous, because VAR results are sensitive to variable definitions, lags, variables included in the VAR and their order, and the unit root and cointegration structure.

To start off, the VAR is specified in levels. This can be a problem for some purposes, especially Granger causality tests, if the variables are non-stationary. Table 2 reports the results of augmented Dickey-Fuller (ADF) tests for non-stationarity and Table 3 reports results of Kwiatkowski, Phillips, Schmidt, and Shin (1992), or KPSS, tests for stationarity. Although the unit root tests are not too robust in small samples, they suggest that all variables are non-stationary in levels (and stationary in differences, although this is not reported). For the purpose of this paper, estimation in levels is satisfactory because testing for causality is not an issue and VAR models in levels with non-stationary variables yield consistent estimates of coefficients and the variance-covariance matrix. This means that impulse response functions and variance decompositions are consistently estimated (Hamilton,1994). More importantly, since the sample period is only 32 years long, no information will be sacrificed. The short sample period is also a reason for choosing a parsimonious lag structure that conserves on degrees of freedom. Likelihood ratio tests of the lag length (as in Hamilton, 1994) do not reject a specification of $p = 2$.[10]

One of the most important issues in specifying a VAR model is the ordering of the variables which for the bivariate case identifies the model. The order of the variables determines which variables are contemporaneously unaffected by shocks to other variables. Since the dispersion measure, *LV*, is first in the order, this means that dispersion is not affected by shocks to

[10]Note, also, that Phillips-Ouliaris (1991) tests for cointegration do not accept cointegration for the *LV* and *E* series. The series would be cointegrated if there were a stable long-run relationship between the mean and dispersion, something which theory has not addressed.

the mean, E. In other words, an LV innovation has a contemporaneous effect on E, but not E on LV. How does one interpret this? The ordering makes sense when one remembers from the definition of the log variance that LV is immune to equiproportionate changes in tax rates. Thus, if all states' ATRs increase equiproportionately, E will increase but LV will be unaffected. This helps to intuitively identify the shocks. Shocks to E, ϵ_{2t} in the VAR equation, are equiproportionate tax shocks which I will interpret as aggregate shocks because all states are affected the same. LV innovations, ϵ_{1t} in the VAR equation, are all shocks that do not affect ATRs equiproportionately and are denoted competition shocks.[11] Thus, the ordering of the VAR is consistent with competitiveness shocks affecting both LV and E contemporaneously and aggregate shocks only affecting E.[12] Other than the restrictions on the ordering, this is an unrestricted VAR which allows the data to determine the feedback effects between the variables and the long-run effects.

While the classification of shocks into competition and aggregate shocks is extreme, it is not implausible and helps sort out the dynamics of the two time series. The shape of the impulse response functions tells us whether this identification is plausible and conforms to tax competition dynamics. Ideally (for easy interpretation) one would like to see some combination of cases A and C which would be consistent with tax competition, or cases B and D for pure expenditure competition. The dynamics also allow one to identify who the leader and follower states are, and

[11]Strictly speaking, differential population changes could also prompt LV innovations. However, this is unlikely to be an issue, because population tends to move relatively smoothly without large discreet jumps.

[12]Note that ordering E first would mean that LV innovations do not affect E contemporaneously. In this case, an ϵ_{2t}-shock is essentially a mean-preserving spread, where the ATRs in both tails of the distribution across states rise, while ATRs closer to the center fall. However, such a shock is much more difficult to interpret as a "competition shock."

depending on who the leaders are, different initial and medium-term responses. How these shocks are propagated through time should be consistent with the stories above.

5. Estimation Results

The estimated impulse responses functions are analogous to dynamic multipliers. They show the dynamic response of one variable to a one standard deviation shock to another variable, where the initial shock is unexpected and only lasts one period but the effects reverberate over time as the variables continue to affect one another. Thus, impulse response functions allow one to infer what kind of relationship exists between variables over time. The estimated impulse responses are plotted in Figures 3 and 4 for $p = 2$.[13] Runkle (1987) points out that reporting impulse response functions without estimating associated standard errors is like reporting regression coefficients without t-statistics. To provide a measure of confidence, Monte Carlo simulations (2500 replications) were used to compute 90 percent and 95 percent confidence bands that are drawn around the estimated impulse responses, although much narrower intervals are not unusual in the time series literature. Given the shocks, forecast error variances are calculated for each variable and decomposed into the percent attributable to each shock. Sims (1982) argues that variance decompositions provide a measure of the strength of the causal relationships between variables, although they do not indicate the direction of these effects. Table 4 reports the percentage of the forecast variance of E attributable to an LV or competitiveness shock for different lag lengths ($p = 2$ or $p = 3$). All results look at the effects of shocks over a 12- year

[13]Results when the lag length is extended to $p = 3$ are not shown, but tend to be less crisp.

horizon.[14]

Are the estimated dynamics consistent with tax competition? The impulse responses in Figure 3 show how *LV*(S) and *E*(S) are related after state level competition shocks or an innovation to *LV*. The initial effect is to produce an opposite effect in *E*(S) and this negative pattern continues through time at a diminishing rate. However, the effects are only significant for the first two to three years. Thus, *LV* innovations have significant short-run effects but insignificant long-run effects. The pattern suggests the sequence continues with cases *C* or *D* throughout. However, given that over the sample period *E*(S) generally increased, it is more likely that the impulse response functions are picking up case *D* which is not tax competition. Since pure expenditure competition is less likely on theoretical grounds (Wildasin, 1988 and Mintz and Tulkens, 1986), the estimates suggest that tax export competition governs state tax rates. In either case, the dynamics are dictated by states with ATRs that are higher than average. Variance decompositions, depicted in Table 4, suggest that the *LV* shocks have a moderate effect on *E*(S). They explain on average 28 percent of the variation in *E*(S) over the horizon using the model estimated with $p = 2$ (with values ranging from 24 to 29 percent), but the estimates may be an upper bound when compared to the model with $p = 3$. Thus, the time series analysis suggests tax export competition shocks explain a moderate amount (or less than thirty percent) of aggregate state tax rate variation.

Figure 4 graphs the impulse responses for local competition shocks. They produce an immediate positive effect on *E*(L). This suggests that either case *A* or *B* is operative - a pattern

[14] I do not discuss the estimates of the *LV* and *E* system with state and local taxes combined because the separate state and local dynamics are more informative. Generally though, estimates tend to be insignificant which suggests offsetting processes are driving state and local tax dynamics.

that continues at a diminishing rate until two years after the shock. From period 3 to 9, case *C* or *D* occurs with *E*(L) falling at the same time *LV*(L) is still rising, although at a decreasing rate. The negative effect on *LV* reaches its peak in period 8, but after period 9, *LV* finally falls, and case *A* or *B* is again operative. The error bands suggest that early effects on *E* and *LV* are significant and, surprisingly, that the negative effects on *LV* in periods 6 through 8 are significant. Variance decompositions shown in Table 4 suggest that in the model with $p = 2$, *LV* shocks explain on average 37 percent of the variation in *E*(L) with values ranging from 19 to 55 percent over the horizon, but the estimates with $p = 3$ suggest that fiscal competition may have even stronger effects.

Is this dynamic path of *LV*(L) and *E*(L) responses consistent with any form of fiscal competition? There are two ways of interpreting the graphs. Suppose that the initial case is *B* - a positive shock to *LV*(L) - and that cases *C* and then *A* follow. Intuitively, this means that the initial competition shock comes from high tax states that raise their tax rates with matching early on by other high ATR states. These early moves are followed by low tax states not matching and lowering their tax rates, moves that are subsequently matched by high tax states that also lower their ATRs. Alternatively, suppose that the initial *LV* shock is negative rather than positive so that early on case *A* obtains, then case *A* is followed by case *D* and then *B*. This means that fiscal competition is initiated by states with below average ATRs that lower their tax rates which is followed by early matching by other low ATR states, but after three years leads to non-matching by states with high ATRs that raise their tax rates, which finally is imitated by low ATR states also raising their rates.

Overall, the first story is consistent with non-matching expenditure competition in

Wildasin (1988) where early tax rate increases by one group of states (with high ATRs) is followed by tax reductions by low ATR states and subsequently by high ATR states. However, while the late matching by high ATR states is consistent with tax competition, the early matching within the high ATR group suggests pure expenditure competition contrary to the findings of Wildasin. On the other hand, the second story of early tax reductions by a group of low ATR states, followed later by tax increases by high ATR states and subsequently by low ATR states, is harder to explain. What explains the non-matching behavior of high ATR states? Mintz and Tulkens (1986) provide one suggestion that early matching behavior comes from states that do not value their public good and that later non-matching behavior arises from states that value theirs.[15] The second story is also harder to explain when looking at the matching behavior later on by high ATR states. Again, pure expenditure competition by the late group of high ATR states runs contrary to theoretical results. Thus, on balance, the first interpretation of the estimated impulse response functions is preferable to the second one, mainly because the first story exhibits fewer inconsistencies with existing theory. Finally, one interesting implication of the first expenditure competition story is that while the local tax rates of the high ATR states tend to revert back to their original levels, the low ATR states end up with lower local tax rates than they started out with.

Finally, the estimated impulse responses to aggregate tax shocks, or ϵ_{1t}-shocks, are presented in the bottom half of Figures 3 and 4. The shapes conform to the stories above, with both aggregate state tax shocks and aggregate local tax shocks having significant effects on

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[15]It is interesting to note that the Mintz and Tulkens explanation is consistent with a North-South divide among U.S. states, with Southern states having lower ATRs than Northern states (Becsi, 1996). However, it is not clear that Southern states also place a lower value on public goods even though their public spending may be lower.

dispersion. The effects on dispersion are negative and significant for at least four years and imply that macroeconomic shocks can trigger local tax rate competition, more so for state tax rates and less so for local tax rates. Aggregate tax shocks also have significant effects on *E* that can persist for several years.

6. Conclusion

A time series approach is used to understand how much fiscal competition matters for state or local tax dynamics and what forms of competition predominate. After an analysis of the interaction of the dispersion of average tax rates (ATRs) and their average across states, one can conclude that fiscal competition has moderate effects on state and local taxes in the U.S., on average explaining one third of the time variation of state and local tax rates, more so for local taxation and less so for state taxation. Also, the estimated impulse response functions suggest a tax export competition interpretation for state tax rate dynamics and indicate that competition is driven by states that have ATRs that are above average. On the other hand, the analysis suggests competition in local tax rates originates with states that have above average ATRs but ultimately leaves states with below average ATRs with lower tax rates than before. On balance, the evidence for competition in local tax rates favors Wildasin's (1988) results on expenditure competition.

These findings are reassuring because they substantiate intuition derived from recent theory, despite the fact that the data are aggregated to the state level and across different tax bases. Time series methods are shown to be useful in uncovering strategic behavior and the empirical results point to fruitful areas for the infant literature on dynamic interjurisdictional behavior. The study also leaves open a few interesting empirical questions. Foremost is the question, if fiscal competition explains one third of the time variation in state and local taxes, what explains the remaining two-thirds? A related question is, what triggers fiscal competition? While aggregate state and local tax shocks are shown to determine the dynamics of tax rates, several other possibilities come to mind that could be analyzed in more general vector autoregression models. For instance, local and state tax dynamics may be connected because of substitution of state for local taxes or expenditures. Or else, differential federal policy shocks such as intergovernmental grants or transfers or aggregate federal policies may be driving dispersion and explaining time variation in state or local tax rates. Preliminary work along these lines point to a potentially important role of state or local expenditures for the dynamics of state or local taxes but an insignificant role of aggregate fiscal tax policies.

Finally, the implications of the analysis are striking with fiscal competition supporting increases over time of state ATRs relative to local ATRs, or increases in the relative size of state government. Although the data support convergence among state ATRs, tax export competition is a force that suggests continuing increases in state ATRs with states with above-average tax rates leading the way. On the other hand, the evidence favors expenditure competition in local tax with no convergence in local ATRs, mean reversion on average, and with below-average tax states driven to compete by continuously lowering tax rates. The policy implications of such an environment depend primarily on whether these trends are deemed to be unsustainable from a welfare perspective - something that is unclear without further analysis of the benefits provided by public expenditures. By the principle of targeting distortions at their source, possible corrective measures may be directed towards reducing federal incentives that encourage competition by states with above-average state ATRs and towards immunizing states with below-average local ATRs from competition.

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Table 1: Mean-Dispersion Combinations of State Tax Rates[1]

	Mean Falls	Mean Rises
Dispersion Falls	Case *A*	Case *D*
Dispersion Rises	Case *C*	Case *B*

[1]Moves by states with higher than average tax rates result in cases *A* and *B*; other cases are due to low tax states.

Table 2: Augmented Dickey-Fuller Tests of Non-Stationarity[1]

	Bayes Information Criterion	Aikake Information Criterion	Bayes Information Criterion	Aikake Information Criterion
Model:	trend and constant		constant only	
LV(S)	1.76	1.76	1.85	1.85
E(S)	0.994	.994	2.32	2.32
LV(L)	1.14	1.14	1.05	1.05
E(L)	3.757*	3.757*	2.19	2.19

[1]A * denotes significant at the 5% level and ** at the 1% level and rejection of the null hypothesis of non-stationarity.

Table 3: KPSS Test of Stationarity [1]

Model:	trend and constant				constant only			
lags=	0	1	2	3	0	1	2	3
LV(S)	.51**	0.28**	0.2*	0.16*	2.3**	1.23**	0.87**	0.69**
E(S)	.61**	0.33**	0.23**	0.19*	2.54**	1.34**	0.94**	0.73*
LV(L)	.63**	0.33**	0.24**	0.19*	0.67*	0.36	0.26	0.21
E(L)	.3**	0.16*	0.12	0.1	1.63**	0.85**	0.6*	0.48*

[1]A * denotes significant at the 5% level and ** at the 1% level and rejection of the null hypothesis of stationarity.

Table 4: Contribution of Competition Shock to the Time Variation of the Mean of ATRs

Contribution To:		*E*(S)	*E*(S)	*E*(L)	*E*(L)
	Lags:	2	3	2	3
	STEP				
	0	24.4 %	18.7 %	30.6 %	41.9 %
	1	28.9 %	13.5 %	27.8 %	41.6 %
	2	29.4 %	14.9 %	22.4 %	44.4 %
	3	28.9 %	10.2 %	18.7 %	42.9 %
	4	28.4 %	1.0%	19.6 %	46.9 %
	5	28.1 %	7.4%	25.5 %	54.5 %
	6	27.9 %	7.4%	34.3 %	61.8 %
	7	27.8 %	7.8%	43.0 %	68.3 %
	8	27.8 %	8.1%	49.8 %	73.2 %
	9	27.7 %	8.2%	54.2 %	76.3 %
	10	27.7 %	8.6%	56.6 %	78.1 %
	11	27.6 %	8.3%	57.6 %	78.8 %
	Average:	27.9 %	9.5%	36.7 %	59.1 %

Figure 1. Dispersion and Mean of State ATRs

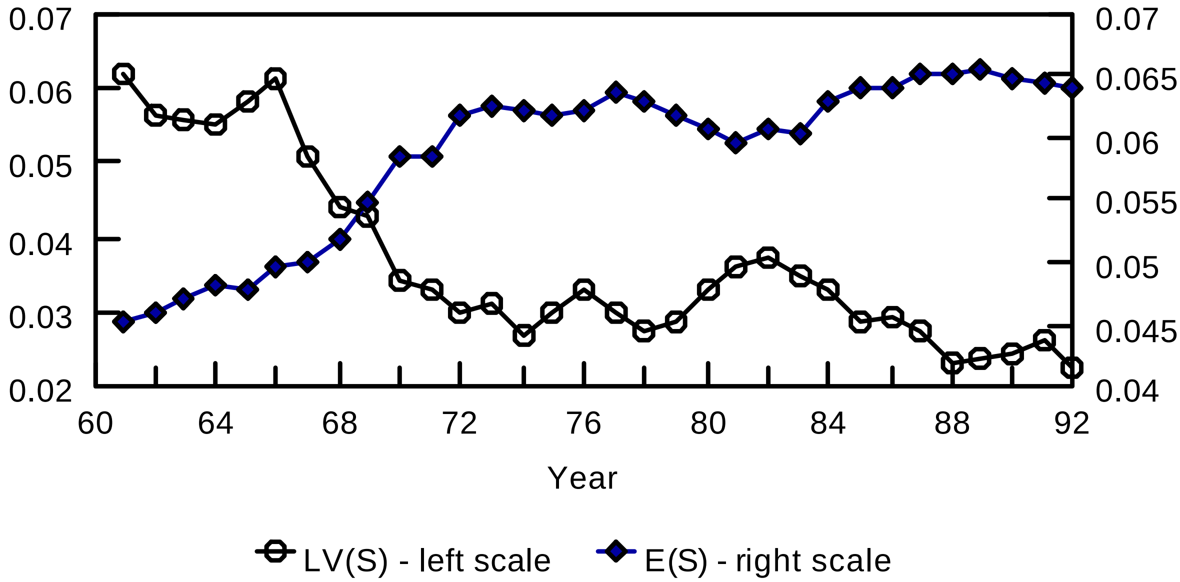


Figure 2. Dispersion and Mean of Local ATRs

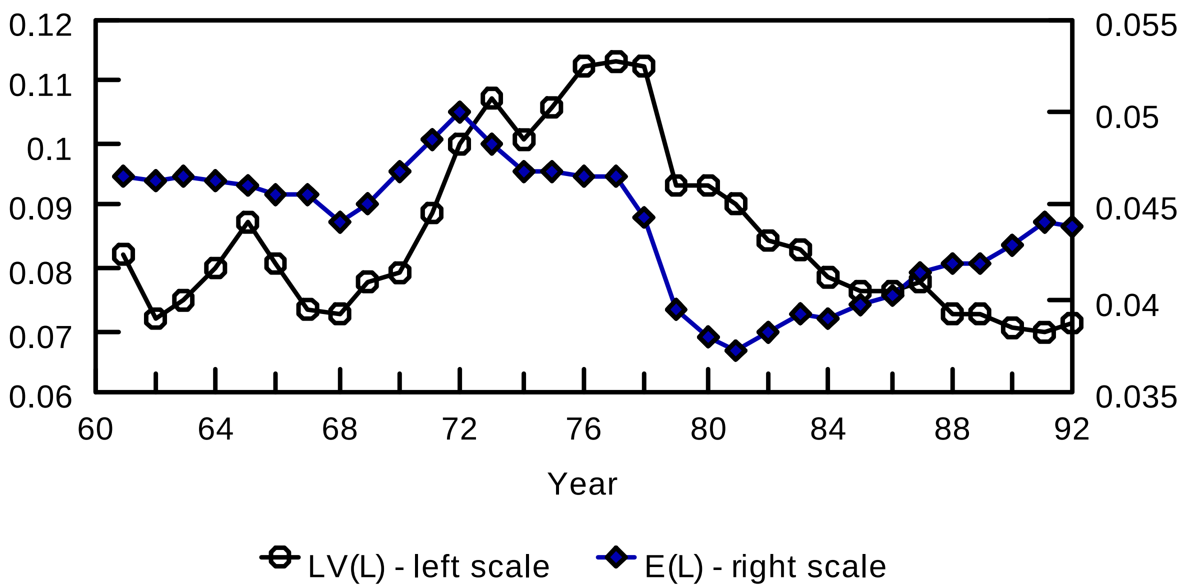
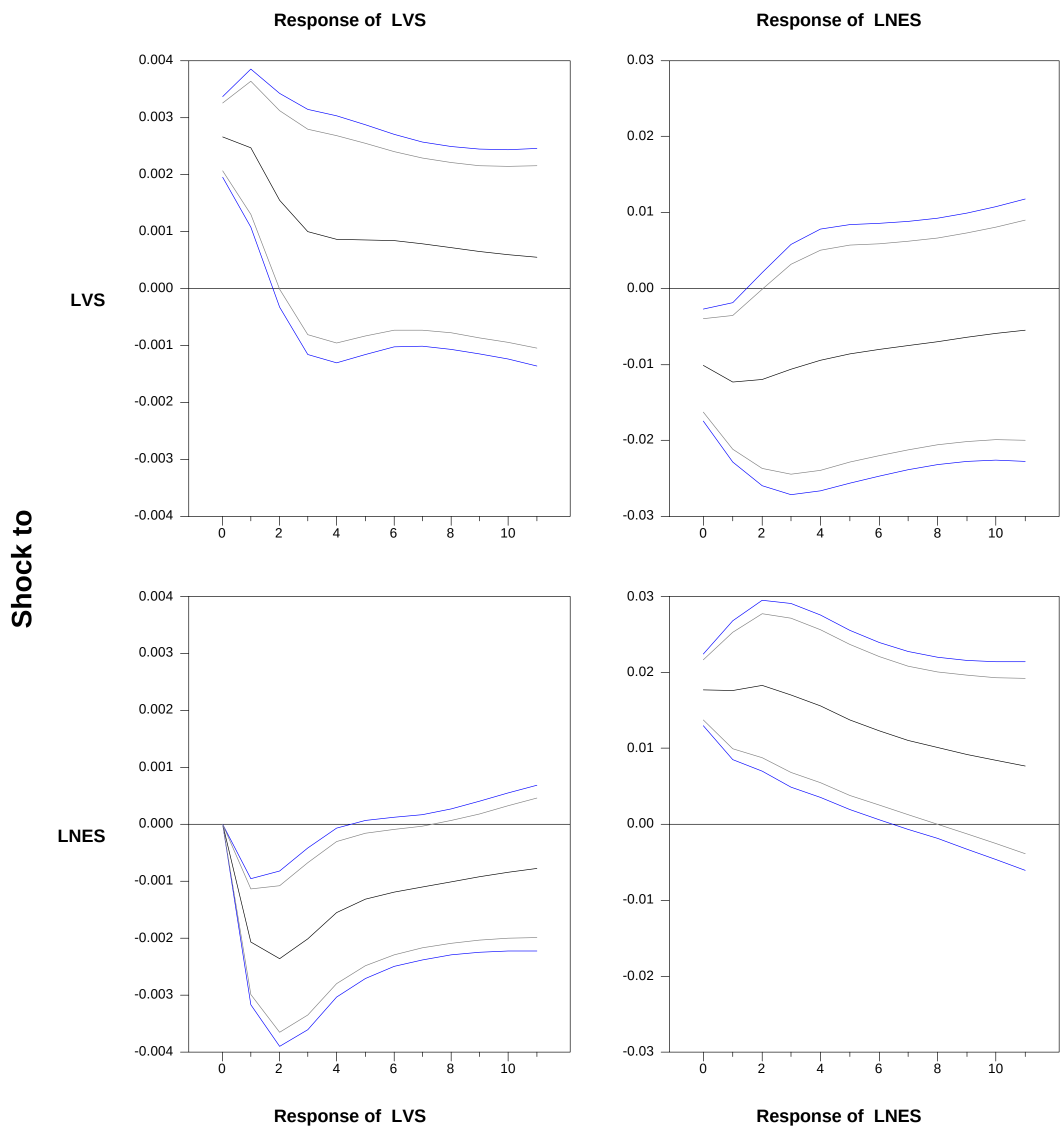
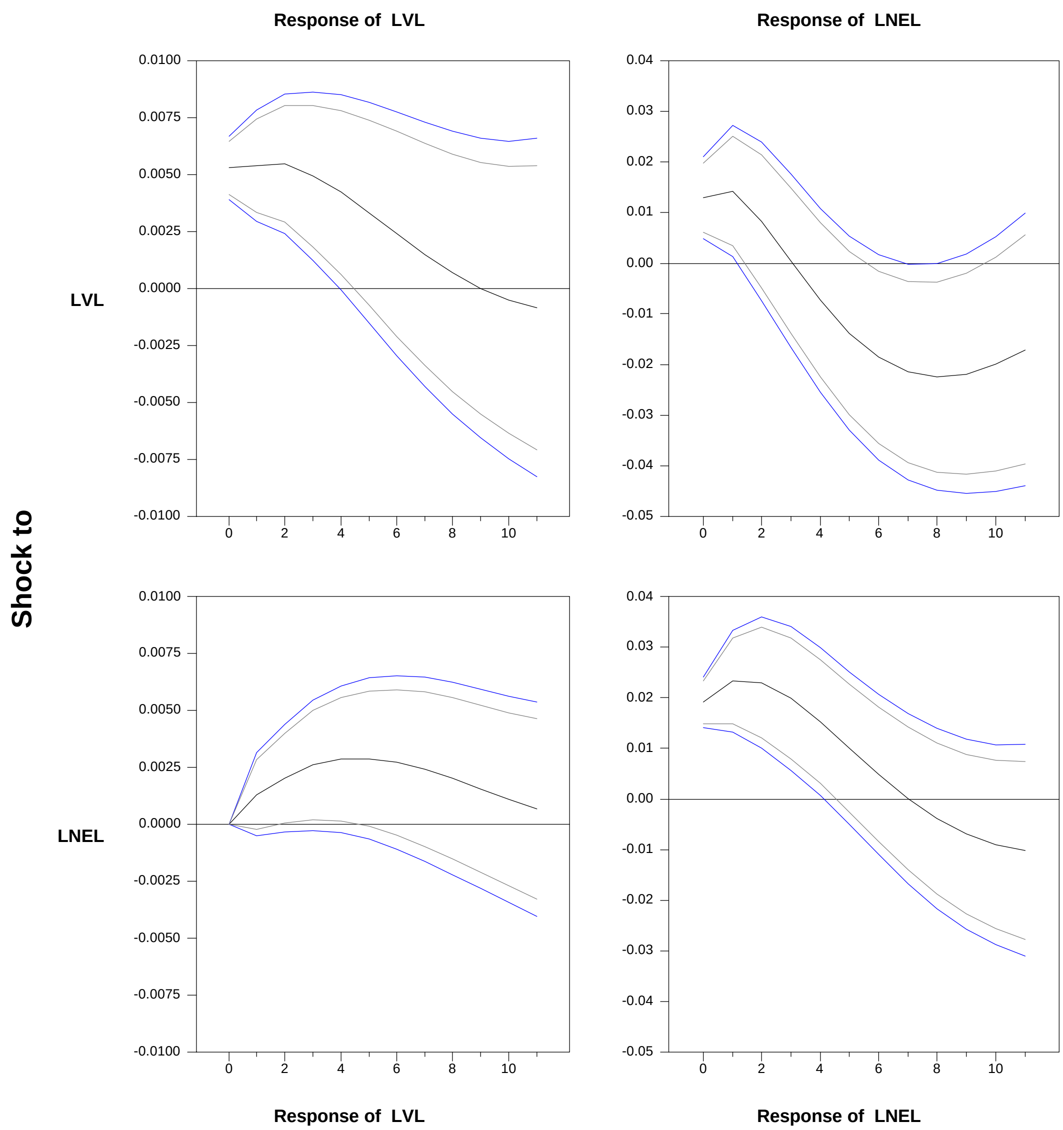


Figure 3. Impulse Responses To State Competition Shocks[1]



[1]Note the top two graphs represent impulse responses to competition shocks, where LVS denotes the log variance of state average tax rates, or *LV*(S) in the text, and LNES is the mean of average state tax rates, denoted ln *E*(S) in the text. The bottom half shows the impulse responses to aggregate state tax shocks. Error bands are drawn for 90 and 95 percent intervals.

Figure 4. Impulse Responses To Local Competition Shocks[1]



[1]Note the top two graphs represent impulse responses to competition shocks, where LVL denotes the log variance of local average tax rates, or *LV*(L) in the text, and LNEL is the mean of average state tax rates, denoted ln *E*(L) in the text. The bottom half shows the impulse responses to aggregate local tax shocks. Error bands are drawn for 90 and 95 percent intervals.