

# Nathan T. Seegert

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Department of Economics  
University of Michigan  
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Economists are undertaking a number of new research questions stemming from the increased demands being placed on state and local governments. For example: new tradeoffs in taxation, the changing roles of supplying public goods in a federal system, and the impacts of state and local government policies on the distribution of population across cities and rural areas. Motivated by the empirical puzzle that state tax-revenue volatility increased 500 percent in the 2000s relative to previous decades, my dissertation considers volatility of tax revenue as a new tradeoff in optimal taxation. The increased demands for state tax revenue and state governments' inability to smooth volatile revenue streams, due to self-imposed balanced budget rules, magnifies budget crises faced by state governments. In addition, I have three papers on the impact of government policies on the distribution of population across cities. In what follows, I outline my work to date as well as the research agenda that I hope to pursue in upcoming years.

## *Optimal Taxation with Volatility a Theoretical and Empirical Decomposition* (job market paper)

I demonstrate U.S. state tax revenue volatility increased by 500 percent in the 2000s relative to previous decades. This increased volatility magnified U.S. state budget crises because of their inability to smooth volatile revenue streams due to self-imposed balanced budget rules. The theoretical model in this paper demonstrates three possible causes of the increase in volatility: changes in tax rates (which change the tax bases states rely on), economic conditions, or tax bases (e.g., what types of consumption are taxable). I find that changes in tax rates alone explain seventy percent of the increase in tax revenue volatility, despite important tax base changes, such as the rise of e-commerce, and amplified business cycles in the 2000s. Motivated by this result, I create a normative model of taxation to consider how governments should tax different volatile tax bases. Typically, taxes are set optimally by minimizing deadweight loss, which in a special case reduces to setting tax rates that are inversely proportional to their elasticities of demand. This model demonstrates that when tax bases are volatile the optimally set tax rates must consider costs from volatile tax revenues (e.g. costs from volatile public consumption) and trade these costs off with deadweight loss. I estimate this optimal condition and find thirty-six states in 2005 relied too heavily on either the income or sales tax, up from twenty-six states in 1965. This increase in inefficiency is due to an increased reliance on the income tax; twelve more states relied too heavily on the income tax in 2005 than did in 1965. This paper finds strong evidence the increase in tax-revenue volatility state governments recently experienced is due to changes in the tax bases on which governments rely, causing states to expose their revenues to unnecessary levels of risk.

## *Welfare Costs and Implications of Volatile Tax Revenue*

This study evaluates the impact of volatile tax revenue streams on state governments and the resulting welfare implications, both theoretically and in a calibrated model. Tax-revenue volatility causes the level of public good to be volatile because governments are unable to perfectly smooth

volatile revenue streams. However, the government is willing to accept some volatility because it enables them to absorb some of the production risk and lower private consumption volatility. Tax revenue volatility is shown to be of first-order importance, in contrast to deadweight loss which has been shown to be of second-order importance. Therefore even small deviations from the optimal tax policy impacts welfare negatively. The calibrated model uses data from the U.S. Census and the Bureau of Economic Analysis and estimates the welfare loss associated with governments minimizing deadweight loss irrespective of the costs to volatility to be \$600 billion.

### *Optimal Tax Portfolios and Shifting State Government Tax Portfolios*

This paper creates a method for estimating government minimum-variance frontiers by formalizing optimal government portfolio analysis. Each tax base a government can tax (e.g. consumption, personal income, and corporate income) is treated as an asset in which the government can invest. In traditional portfolio analysis the weights an investor puts on different assets has no effect on the asset's mean, variance, and covariance. However, as the government puts more weight on one of its assets by increasing the tax rate, the asset's mean, variance, and covariance changes. The theoretical model demonstrates how leakage from deadweight loss and horizontal externalities from other tax bases change the mean, variance, and covariance of the government's assets. If these considerations are not accounted for, the government will systematically underestimate the increase in volatility of its tax revenue from an increase in one of its tax rates. Therefore, leakage and horizontal externalities need to be considered when estimating the minimum-variance frontier for governments. The method I develop in this paper to estimate a government's minimum-variance frontier is demonstrated using data from U.S. state governments from 1951-2010. This application demonstrates how state governments have shifted their tax portfolios and the heterogeneity that exists across states and across time within a state.

### *A Sequential Growth Model of Cities with Rushes*

This paper models the life-cycle of a city from creation to steady state. In the model, cities are subject to both economies and diseconomies of scale, causing average income within a city to have an inverted U-shape with respect to city population. Cities provide benefits to migrants based on when the migrants enter the city. These rank benefits model the fact that early migrants benefit from being able to choose the best land, establish firms first, and have a larger impact on the institutions within the city. Homogenous individuals, living in existing cities that grow at an exogenous rate, decide in an uncoordinated manner both when to create, and when to migrate to, new cities. The model produces an endogenous pattern of migration that is able to match three empirical facts: 1) most cities continue to grow over time, 2) cities grow sequentially, and 3) some cities experience rushes in migration. Finally, the model demonstrates the impacts of the income and property tax on city creation and growth and compares the life-cycle of a self-organized city with the optimal pattern of city growth.

### *Barriers to Migration in a System of Cities*

This paper creates a model of city creation and growth to analyze how different barriers to migration affect the resulting system of heterogeneous cities. How many and which set of cities are

created is shown to differ based on the barriers to migration that exist in the system of cities. In this model individuals create and move across cities to maximize their utility. Barriers to migration affect the fundamental wedge that is created when uncoordinated individuals disregard the impact of their migration decision on people in the city they choose to live in. I find that there exists an optimal level of barriers to migration such that if the barriers are larger or smaller the population distribution and the number and set of cities created are suboptimal. Surprisingly, I find when barriers to migration are capitalized as fees charged to migrants the population is efficiently distributed across the optimal number and set of cities. This result extends Knight's toll road result to the extensive margin in the context of cities.

*Optimal Population Distribution across Cities and the Private-Social Wedge* (with David Albouy)

The conventional wisdom is that market forces cause cities to be inefficiently large, and that public policy should limit city sizes. This wisdom assumes, unrealistically, that city sites are homogeneous, that land is given freely to incoming migrants, and that federal taxes are neutral. In a general model with city heterogeneity and across-city externalities, we show that cities may be inefficiently small. This is illustrated in a system of monocentric cities with agglomeration economies in production, where across-city externalities arise from land ownership and federal taxes. A calibrated model accounting for heterogeneity suggests that in equilibrium, cities may be too numerous and underpopulated.

*Future Work*

I intend for my research agenda to focus on tax and urban policy by combining applied theory and empirical analysis, as I have in my work to date. I have two projects underway that demonstrate this research philosophy. In one particular project with Eric Ohrn, a fellow graduate student, we demonstrate a mechanism for dividend taxation to affect firm merger decisions. We test the model using data from 2000 through 2010 on all public firm mergers using variation from the dividend tax rate change in 2003. Preliminary results suggest that decreasing the dividend tax decreased the number of inefficient mergers, consistent with the theoretical model. This result is a new explanation for the merger failure puzzle, which demonstrates that a majority of mergers depress the acquirer's stock price.

I also intend to expand on preliminary work with Scott Page on the impact of skill and luck in creating optimal tournaments and optimal screening. This work decomposes skill and luck into endogenous and exogenous factors. The model demonstrates total effort can decrease as the size of the prize given to the winner increases and the existence of an optimal level of luck within a tournament. These results have straightforward applications in labor markets. I intend to use these results to generalize optimal taxation models, which can be reinterpreted as a combination of an optimal tournament (with the objective of maximizing effort) and optimal screening (with the objective of differentiating ability and effort for redistribution purposes). For example, Varian's 1980 paper and Mirrlees' 1971 paper can be reinterpreted as an optimal tournament and an optimal screening problem respectively. My future work combining optimal tournament and screening models would nest the concepts in those papers and extend them with additional skill and luck tradeoffs.