

**Growth and Stability of Local Government Taxes:  
An Analysis of the Lexington-Fayette Urban County  
Government's Tax Revenue Portfolio**

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## **EXECUTIVE SUMMARY**

Adequate tax revenues are critical for a government to operate and maintain the delivery of services that its citizens depend. The stability of these revenues is necessary for a government to accurately forecast future revenue growth and to ensure that balanced-budget requirements are met. The Lexington – Fayette Urban County Government (LFUCG) depends upon five primary tax sources for nearly 95% of its tax revenue. These taxes comprise the city’s tax revenue portfolio and include the business net profits tax, employee withholdings tax, franchise tax, insurance premiums tax, and the property tax. Each of tax possesses unique characteristics that dictate their susceptibility to year-to-year fluctuations. These tax sources, on average, maintain a disproportionate share of the total tax revenue portfolio, ranging from 61.4% to 4.8%.

This research sought to identify the tax sources which the city depends on most for its tax revenue, their respective degree of volatility, and whether the current tax revenue portfolio is “mix-efficient” with regard to the Markowitz portfolio model. Data for these five tax sources from FY 1993-2007 was used to find the relationship each of tax has on the other taxes within the portfolio. The analysis found that a positive relationship to exist between each possible tax pairing, except for the employee withholding tax-insurance premiums tax combination and the franchise tax-insurance premiums tax combination. A study of variance-covariance of the taxes supported that assumption that the presence of two or more taxes serve to reduce the volatility of the tax revenue portfolio, where the variance of the entire portfolio was significantly less than the variance of any single tax, except for the property tax.

Using the coefficient of variation as a method of statistical dispersion, the following research found the tax source which the city depends on most, the employee withholding tax (61.4% of the tax revenue portfolio) has low level of unitized risk. This infers that the tax source experienced low volatility during the fifteen-year period, relative to the other taxes in the portfolio.

The Urban County Government may choose to change the proportions of the tax shares within the revenue portfolio in order to reduce volatility. By placing greater weight on a tax share with lower historical volatility, it can improve the volatility of the overall tax revenue portfolio. However, such an adjustment will reduce the expected the return of the portfolio. Reducing the volatility, a normative concept, through an adjustment of the tax shares has yet to be seen largely due to the theoretical nature of process coupled with the underlying difficulties in undertaking such an activity. Furthermore, academic literature suggests that adjusting the portfolio may not be a necessary requirement for averting risk within a portfolio.

## **INTRODUCTION**

Like most city governments, the Lexington-Fayette Urban County Government (LFUCG) depends on multiple sources for its operating revenue. These include taxes, user fees, grants, and intergovernmental transfers. However, local taxation of wages, business net profits, and tangible property are the primary revenue vehicles on which the city depends most heavily for its operating revenue. Recently, a task force was assembled by the Lexington-Fayette Urban County Government to discuss the financial condition of the Lexington-Fayette Urban County Government. Government officials made it clear the city needed gain a better grasp of its tax and revenue sources. Accordingly, this research appeals to that need by examining the five primary tax sources of the LFUCG; each of these taxes contributing a substantial proportion to the city's revenue portfolio. Furthermore, this analysis serves to preface a further investigation of the city's tax portfolio through the application of a financial portfolio model. Multiple studies have applied a portfolio model to a state tax portfolio (White, 1983; Misiolek and Perdue, 1987; Perdue and Weed, 1991) and one has applied a portfolio model to a local government's tax portfolio (Berg et al., 2000).

This project begins with a discussion of local and state government tax administration, followed by an explanation of the critical importance of stable tax sources. From here, the Markowitz model of portfolio theory is explained, extended by an analysis of the Urban County Government's tax sources. The analysis integrates the statistical measures of correlation and variance-covariance as methods to observe the interactions of the Urban County Government's five primary tax sources. To measure the volatility of the tax sources, the coefficient of variation, a statistical measure of dispersion, is applied. Subsequent to this analysis, the

limitations of the research will be discussed, as will the rationale for using a portfolio model to measure portfolio efficiency. The report concludes with a discussion with respect to the appropriateness of applying a portfolio model and validity concerns regarding the use of such a model

### *Tax Administration – Importance of Taxes to Local Governments*

The ability of government to capture resources from private consumers for public use is a fundamental practice exercised by a government that permits it to operate in a market economy (Schumpeter, 1991). These revenues enable governments to purchase the necessary resources to be used in the delivery of public services; thus the importance of revenue from taxation as funding source to local governments. Break and Pechman (1975) emphasize the importance of tax administration, as means of producing sufficient revenue for public agencies, stating “The primary goal of taxation is to transfer control of resources from one group in society to another and to do so in ways that do not jeopardize, and may even facilitate, the attainment of other economic goals.” Accordingly, a tax policy must minimize damages done by the transfer of resources by not only concerning itself with raising money, but how this money is raised and from whom it is raised.

### *Basis for Stable Tax Sources*

It is imperative for budget analysts and senior staff to understand the primary tax sources that contribute to the LFUCG’s revenue portfolio, the expected annual returns of tax source, and the forces of influence behind each tax source. Identifying these tax sources and their respective forces of influence is critical in the revenue forecasting process. The city of Lexington, like all

U.S. local governments, must maintain a balanced budget and avoid incurring a budget deficit at the end of any given fiscal year; thus the need for accurate revenue forecasting methods.<sup>1</sup>

Intuitively, for a local government to forecast future revenues, with some accuracy, staff must precisely understand the exogenous variables that influence and promote change in the level of revenue received by the government. Furthermore, these individual revenue streams must be predictable in order to maintain a sufficient level of revenue to cover cost increases from inflation and additional spending. To guarantee the city is achieving a sufficient level of revenue to meet its expenditures, it must maximize revenue returns from its primary tax sources and minimize exposure to high-risk tax sources.

Groves and Kahn (1952) describe a stable tax system for state and local governments as one that sustains a given volume and quality of governmental services throughout the various phases of the business cycle. Unfortunately, this approach failed to account for growth in tax revenue to finance the increase in public services that have occurred over time. Long run and short-run income elasticities have been used to quantify growth and stability, respectively (Williams et al. 1973). The income-elasticity approach provides a rather intuitive approach to choosing between two taxes, but does not illustrate a method that will enable a government develop an efficient revenue portfolio.

Furthermore, the importance of balanced revenue sources is critical during periods of dwindling federal revenue sharing with state and local governments (Forerster and Spindler, 1990). While LFUCG depends minimally on the federal government for revenues, this is an important consideration that policymakers must be aware of. Under the State and Local Fiscal Assistance

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<sup>1</sup> Kentucky Revised Statutes, Ch. 91A.030 (1992) ; Kentucky Constitution Sect. 157B

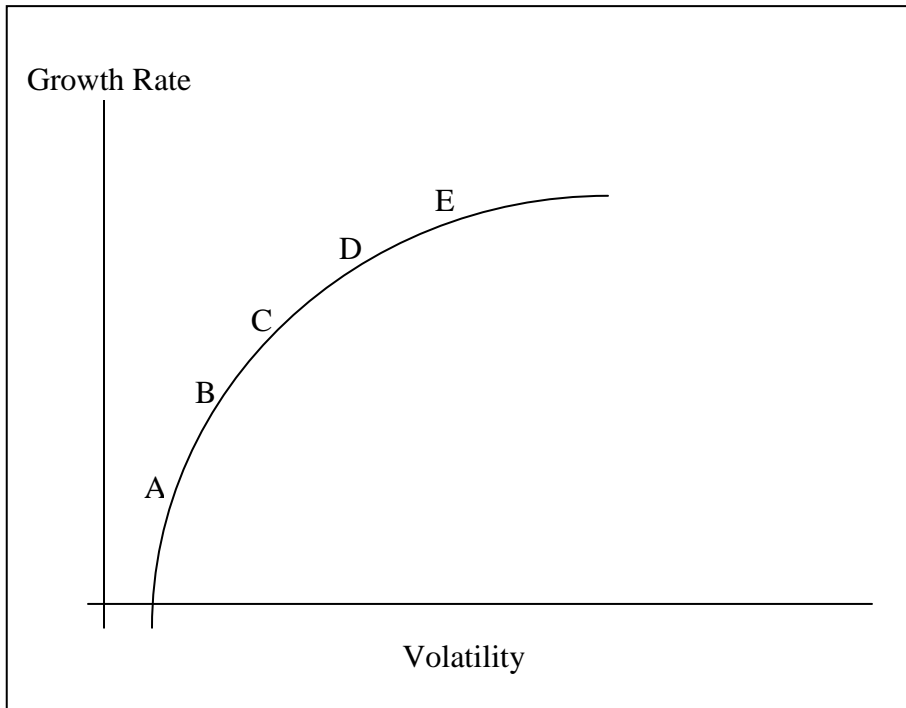
Act of 1972, the federal government shared a portion of its revenues with states and local governments. In years following the enactment of the federal legislation, states were dropped from the list of beneficiaries because many had budget surpluses and could not justify a need for the federal support (Lee, Johnson, and Joyce, 2004). Initially, the property tax was used by local governments to facilitate most of its spending as it presented a stable, predicted source of revenue (White 1983). Also, it was widely considered that by using the property tax to fund services for the local community consequentially increased the economic value of property within the community (Lee, Johnson, and Joyce, 2004). However, over time, demand for government services has undoubtedly increased. Therefore, to meet this demand a greater variety of taxes have been instituted to finance the meet increases in the level of government spending (White 1983). As a result, the proportion that these taxes contribute to a government's total revenue has grown as consumption and income has increased.

### **CONCEPTUAL FRAMEWORK**

#### *An Optimal and Efficient Revenue Portfolio*

Earlier researchers focused their attention on the use of diversification by states as a means to reduce instability in revenue receipts. The seminal work of White (1983) provided an integrated approach to determine an efficient revenue portfolio based on fundamental economic principles. This approach enabled the development and comparison of a large number of revenue portfolios, by adjusting the levels of tax sources. Each of these portfolios has a given growth rate and degree of volatility, providing the policymaker with a menu of available portfolios, as shown in Figure 1 below.

**Figure 1. Growth – Volatility Frontier (ABCDE)**



Among the potential portfolios that can be constructed, policymakers are most interested in portfolios that are mix-efficient. Mix-efficient portfolios provide the lowest degree of volatility for any given amount of growth. An efficient mix combination of tax sources (efficient frontier) is depicted in Figure 1 by the curve ABCDE. This curve is bounded on one end by point A which, indicating the least amount of volatility among all possible portfolios, and by point E on the other end, indicating the highest growth rate of all portfolios. Only points tangent to this curve, such as A, B, C, D, and E are considered efficient; a portfolio to the right of arc ABCDE fails to maximize growth given the level of volatility.

Misiolek and Perdue (1987) build on the foundation constructed by White through the integration of real and nominal frontiers into the growth-instability model. They recognized that

factors such as inflation could affect different taxes differently. Furthermore, they found that the efficient frontier in nominal terms might be inefficient when a government's goal is real revenue stabilization. The focus of their research was on seven main revenue sources for the state of Georgia during 1970-1981. Gentry and Ladd (1994) extend White's methodology and incorporated a broader set of characteristics and directly compared two states, Massachusetts and North Carolina. Their research focused on four characteristics of state structures: revenue growth, stability, equity, and competitiveness. Mallick and Harmon (1994) further extended White's research in portfolio efficiency to include equity concerns. They analyzed the growth, stability, and progressivity of individual taxes in New York State. Braun and Otsuka (1998) examined the contributions of a state's economic condition and the tax structure to the growth and variability of tax revenue flow. The scope of their research focused upon the interaction of the tax structure with the state economy to constrain the choices available to government officials. Berg et al. (2000) was the first to apply White's seminal research to local government revenues. Their research focused on the growth, stability, and progressivity of the four main tax sources of New York City by applying the Modern Portfolio Theory pioneered by Harry Markowitz.

### *The Markowitz Model Explained*

The Markowitz model applies probability theory to portfolio selection (Markowitz, 1952). The object and rationale of using such a model resides in its ability to determine the level that certain securities move or fail to move in unison and provides a theoretical framework for analysis of risk and return and their inter-relationships. Markowitz generated a number of portfolios within a given number of securities. Expected returns and related risk of each security allows an

individual investor to create a portfolio from a combination of assets that will satisfy an investor's preferences with respect to return, risk, and investment requirements. Given these preferences, portfolio selection is not a simple choice of any one specific security securities, but a right combination of securities (Markowitz, 1952; Markowitz, 1987; Fabozzi, 2002; Fabozzi, 2006). Added emphasis is placed on the quality of a portfolio because it will be different from the quality of individual assets within it. Accordingly, the combined risk of two assets taken separately is not the same risk of two assets together. Counter to the Traditional Theory of portfolio investment relies on the standard deviation as a measure of variability and uses this measure to dictate which assets should be included in the portfolio (those with lower variability). The Modern Portfolio Theory, on the other hand, emphasizes the need for maximization of returns through a combination of securities, whose total variability is lower. The risk of each underlying asset is different from that of others and by formulating a proper combination of assets in a given portfolio, diversification, we can arrive at an "efficient" portfolio. An efficient portfolio in Markowitz terms will be a portfolio with an asset combination where the risk of one asset is offset (hedged) partly or fully by that of the other.

Integrating diversification into the theoretical framework, Markowitz (1952) postulated that diversification should not only attempt to reduce the risk of a security by reducing its variability or standard deviation, but by reducing the covariance between two or more underlying assets in the portfolio. Empirically, combining different securities within a given portfolio makes it possible to have a range of risk varying from zero to infinity (Markowitz, 1952; Markowitz, 1987; Fabozzi, 2002; Fabozzi, 2006).

## **RESEARCH PROBLEM**

This analysis examines five aspects of local government revenue sources: (1) it identifies the primary tax sources of the city government; (2) it determines the extent to which the city depends on each tax source for supporting its expenditures; (3) it identifies the degree of correlation of the tax sources; (4) it defines the degree of interaction among the tax sources; and (5) defines the volatility of each tax source within the portfolio. Ultimately, this research attempts to answer the following questions, “Does LFUCG receive tax revenue from unstable tax sources? Should a local government strive to maintain a revenue portfolio that is mix-efficient? Is the current revenue portfolio “mix-efficient” with respect to Markowitz Modern Portfolio Theory?”

## **DATA AND METHODOLOGY**

This research is based on the five primary tax sources used by the LFUCG during the FY 1993-2007 periods. The tax data were extracted from LFUCG’s Comprehensive Annual Financial Report filed at the end of each fiscal year. These data represent revenue reported in Generally Accepted Accounting Principles (GAAP) basis. For the following analysis, the data have been placed on the same base, been adjusted for inflation, and are reported in 2007 dollars.<sup>2</sup> However, they are not based on a common rate and therefore do reflect changes in tax policy. Difficulty in eliminating all imposed tax changes over this fifteen-year period was not possible.

## **ANALYSIS AND FINDINGS**

### *Lexington – Fayette Urban County Government’s Five Primary Taxes*

Local taxation provides nearly all of Lexington’s revenue. In FY 2007, local taxes comprised nearly 90% of the Urban County Governments General Fund revenue. As Table 1 below

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<sup>2</sup> In text illustrations will be noted when adjusted data have been used for the analysis.

illustrates, LFUCG’s revenue portfolio for fiscal year 2007 heavily relied upon licenses, property taxes (ad valorem taxes), and permits. These revenues accounted for 90% of the Urban County Government’s General Fund tax revenue.<sup>3</sup>

**Figure 2.**  
**Lexington - Fayette Urban County Government Revenue, FY 2007**

<b>Category</b>	<b>FY 2007 Budget</b>	<b>% of Total Budget</b>
Licenses and Permits	\$ 207,019,970	82%
Ad Valorem Taxes	17,918,540	7%
Services	16,286,270	6%
Detention Centers Revenue	3,698,500	1%
Miscellaneous	4,719,340	2%
Intergovernmental	2,158,560	1%
Fine and Forfeitures	95,500	0.04%
<b>Total Revenue</b>	<b>\$ 251,896,680</b>	<b>100%</b>

\*Source: Lexington - Fayette Urban County Government, Office of Budge and Policy

Of the \$224,938 million collected in tax revenues in FY 2007, 98% came from five main sources: (1) the employee withholding tax, totaling \$143,474 million, accounting for 61.6% of total tax revenue; (2) the business net profits tax, totaling \$30,436 million, 13.1%; (3) the insurance premiums tax, totaling \$20,773 million, 8.9%; (4) the property tax, totaling \$18,526 million, 7.9%; and (5) the franchise tax, totaling \$15,007 million, accounting for 6.4%. The employees withholdings tax, business net profits tax, insurance premiums tax, and franchise tax fall under the heading “Licenses and Permits” in Figure 2 above. The heading “Services” denotes revenue received by LFUCG from user-fees or charges-for-services, such as golf and swimming activities. The remaining 2 percent of tax revenues are derived from twenty other

<sup>3</sup> FY 2007 Budget in Brief, Lexington-Fayette Urban County Government Office of Budget and Policy; <http://www.lexingtonky.gov/Modules/ShowDocument.aspx?documentid=2886>. These are nominal data.

taxes, none of which yielded more than 0.5% of total tax revenue. The larger of these include the regulated license fee (0.03% of total tax revenue), the Public Service Commission tax (0.02%), and individual tax returns (0.005%).

The *employee withholding* and *business net profits taxes* are income sensitive taxes. During periods of economic expansion, these two taxes often increase relative to property, insurance, and franchise taxes. As businesses in the Lexington-Fayette county region add employees to their payrolls, employee withholding tax receipts increase, on average. Similarly, as business net profits grow as a result of increased economic activity, business net profits taxes increase, on average.

The *property tax* is structured in a way that limits volatility. Property tax revenue is determined by taking the assessed value of tangible property and applying the current year's tax rate. The Fayette County Property Valuation Administrator conducts assessment of real property in the County and determines their assessed value. In 1979, the Commonwealth of Kentucky enacted legislation limiting the amount of property tax revenue a local government may collect. Under provisions of this legislation (known as HB 44) the property tax rate imposed by local governments cannot be set at a level that increases property tax revenue by more than 4% above the revenue collected during the preceding year (Wildasin et al., 2001). However, a local government can exceed the 4% limit in property tax revenue growth if voters, in a special election, fail to overturn the measure.

The *insurance premiums tax* is levied on life, casualty, and health insurance premiums held by insurance carriers in Lexington – Fayette County. Kentucky is one of six states that permit its local governments to levy taxes on insurance premiums (Thompson et al., 2007). Tax revenues from the insurance premiums tax vary moderately year-to-year largely due to difficulties in remittance and enforcement of the tax returns.

The *franchise tax*, or franchise fee, is levied on public utility service providers in Lexington – Fayette County. Franchise fees apply to telecommunications, electricity, and natural gas. The Kentucky Public Service Commission regulates the rate at which these taxes are levied. Initially, it is assumed that fluctuations in rate changes correspond to limited volatility in the tax receipts from As such, tax revenues from the local franchise fees exhibit little variation year-to-year.

#### *Growth and Volatility of Lexington – Fayette Urban County Government Tax Revenue*

For the period FY 1993-2007, average tax shares using real revenue data, were as follows: employee withholdings, 61.47 %; business net profits, 10.70 %; insurance premiums, 9.06 %; property, 8.07 %; franchise, 4.89 %. For the fifteen-year period, the five taxes combined had an annual growth rate of 2.60 percent and had a variance of 0.310 percentage points. The business net profits tax had the highest annual growth for the period, 6.84 percent, and was the most variable tax source according to the variance. As expected, the property tax was the least variable of the tax sources, with a variance of 0.10 percentage points and had an annual growth of 0.66 percent. The variance of the overall portfolio is less than all the individual tax sources, except the property tax. This is due to the presence of stabilizing taxes, which are tax sources

that reduce instability through interaction with other taxes. In the LFUCG portfolio, the primary stabilizing tax is the property tax. (See Figure 3 below.)

**Figure 3.**

**Lexington - Fayette Urban County Government Tax Revenue Shares, Growth Rates and Variances, FYs 1993-2007**

<b>Tax</b>	<b>Share of Revenue</b>	<b>Average Growth Rate</b>	<b>Variance of Growth Rates (percentage points)</b>
Business Net Profits	10.70%	6.84%	1.80
Employee Withholding	61.47%	2.39%	0.36
Franchise	4.89%	4.19%	0.76
Insurance Premiums	9.06%	1.35%	0.42
Property	8.07%	0.66%	0.10
<b>Total (5 taxes)</b>	<b>94.19%</b>	<b>2.60%</b>	<b>0.310</b>

\*All data are on a common base and adjusted for 2007 dollars.

\*\*Average Growth Rate represents the average annual percent change for each tax source.

In Figure 4 below, a correlation matrix is constructed serving to illustrate the relationship between each of the tax sources.<sup>4</sup> The measure of correlation calculates the strength of a relationship between two variables, in this case two tax sources. In this analysis, the interaction among all tax sources resulted in a positive relationship, except in two instances. These findings are consistent with the initial assumption that taxes grow in unison and that the presence of one tax will positively affect the growth of another, on average.

<sup>4</sup> The formula for correlation can be found in the Appendix.

**Figure 4.**

**Correlation Matrix of Lexington - Fayette Urban County Government Taxes, FY 1993-2007 (Percentage Points)**

	<b>Business Net Profits</b>	<b>Employee Withholdings</b>	<b>Franchise</b>	<b>Insurance Premiums</b>	<b>Property</b>
Business Net Profits	1.0000				
Employee Withholdings	0.8525	1.0000			
Franchise	0.0683	-0.2391	1.0000		
Insurance Premiums	0.4574	0.5734	-0.0963	1.0000	
Property	0.3621	0.1363	0.1613	0.2497	1.0000

\*All data are on a common base and adjusted for 2007 dollars.

\*\*Data represent the variance-covariance of the average growth rates of each tax source.

As Figure 4 above illustrates, the business net profits tax is highly correlated with the employee withholdings tax. Given the nature of the business net profits tax, one would intuitively believe that as a business experiences an increase in net profits, it would find it advantageous to hire more employees. The addition of these employees on the payroll would ultimately infer an increase in tax receipts from the employee withholdings tax. While this measure of statistics provides information regarding the interaction among the variables, it does not insist that the growth of any tax source is caused by another tax source. It conveys the degree of the relationship any two of the taxes might have, with a 1.00 correlation implying a strong positive correlation and -1.00 implying a strong negative correlation.

To extend the previous analysis and determine the affect each a source has on the other tax sources within the portfolio, a variance-covariance matrix was constructed.<sup>5</sup> In Figure 5, the variance of each tax source is the number atop the diagonal; the covariance is displayed below the diagonal. A positive coefficient between two variables indicates the interaction between the two taxes increase the variability of the portfolio.

<sup>5</sup> The formula used to develop the variance-covariance matrix can be found in the Appendix.

**Figure 5.**  
**Variance-Covariance Matrix of Lexington - Fayette Urban County Government Taxes, FYs 1993-2007**  
**(Percentage Points)**

	<b>Business Net Profits</b>	<b>Employee Withholdings</b>	<b>Franchise</b>	<b>Insurance</b>	<b>Property</b>
Business Net Profits	1.801				
Employee Withholdings	0.684	0.357			
Franchise	0.080	-0.125	0.765		
Insurance	0.396	0.221	-0.054	0.416	
Property	0.156	0.026	0.045	0.052	0.103

\*All data are on a common base and adjusted for 2007 dollars.

\*\*Data represent the variance-covariance of the average growth rates of each tax source.

For example, the covariance of the business net profits tax and the employee withholdings tax is 0.684 percentage points. This infers the interaction of the business net profits and the employee withholdings tax increases the variability of the portfolio by 0.684 percentage points. Also, it should be noted that given the stabilizing nature of the property tax, it is not surprising the results indicate that the property tax has a low covariance with the other taxes in the portfolio. A negative relationship between two tax variables indicate the interaction between the tax sources reduce variability. Two tax interactions, as depicted in Figure 5, illustrate this behavior: the employee withholdings tax-franchise tax and franchise-insurance tax. Similar to the above analysis, the interaction of these two taxes result in an overall reduction of variability within the portfolio, on average.

To determine the level that the Urban County Government depends on revenue from unstable tax sources, the coefficient of variation (CV) was found for each tax source.<sup>6</sup> The mean annual adjusted tax revenue for each tax was divided by its respective standard deviation; thus, creating a normative statistical measure of dispersion. Simply put, this the ratio of the standard deviation

<sup>6</sup> The formula for the coefficient of variation can be found in the Appendix.

of each tax source to its arithmetic mean, where a  $CV > 1$  infers over-dispersed data and a  $CV < 1$  infers under-dispersed data. In Figure 6 below, the share of revenue is shown alongside its corresponding CV. From this illustration, the tax revenue with the largest portfolio share (employee withholdings tax) returned the second lowest coefficient of variation, 0.061, among all tax sources, implying a low level of unitized risk over the fifteen-year period.<sup>7</sup> This implies that one standard deviation in the employee withholdings tax is equal to 6.1% of its mean value.

**Figure 6.**  
**Lexington - Fayette Urban County Government Tax Revenue Shares and**  
**Coefficients of Variation, FYs 1993-2007**

<b>Tax</b>	<b>Share of Revenue</b>	<b>Coefficient of Variation</b>
Business Net Profits	10.70%	0.200
Employee Withholding	61.47%	0.061
Franchise	4.89%	0.312
Insurance Premiums	9.06%	0.067
Property	8.07%	0.034

\*All data are on a common base and adjusted for 2007 dollars.

\*\*The coefficient of variation was determined by dividing the mean real revenue receipt for each tax source by its standard deviation.

The tax share with the largest level of unitized risk is the franchise tax, with a CV of 0.312, or 31.2%. This high CV could be from changes in the franchise tax policy that took place during FY 2004 as part of the Commonwealth's Tax Modernization Plan. Nonetheless, it is interesting to find a high degree of instability in a tax source otherwise thought to be benign.

The business net profits tax, with a tax revenue share of 10.70%, returned a CV of 0.200, or 20%; thus, one standard in the business net profits tax is equal to 20% of its mean value. Given

<sup>7</sup> Unitized risk is the percentage of the mean represented by one standard deviation. The larger the unitized risk, the greater the standard deviation-to-mean ratio.

the susceptibility of this tax to economic fluctuations, one can assume that part of the variation of this tax source is due to fluctuations in the local economy over the fifteen-year period of study.

The Urban County Government may choose to alter the tax shares for each of the tax sources in order to improve stability or increase returns. While shifting a greater proportion of the portfolio share in favor of more franchise taxes or business taxes will directly increase receipts from these categories, this shift also increases the likelihood of volatility. A shift in the portfolio's tax shares that increases the proportion of the property tax reduces the tax receipts and volatility of the portfolio, but is constrained by state law. Ultimately, the size of the tax base will determine how much the revenue portfolio can be altered. These areas of concern are discussed at the conclusion.

### **LIMITATIONS OF ANALYSIS**

As stated earlier, one of the limitations of this analysis stems from the fact that the data have not been adjusted for changes in tax policy that have taken place over the period of analysis. Placing the data on a common base and adjusting for inflation reduced the presence of outside noise; these outside influences could be further reduced by adjusting the data for tax changes. The size of the period (fifteen years) was used because of limited access to data from years prior to 1993. However, given the dynamic nature of the data analyzed, it was the author's decision to include fifteen years of data because older data might jeopardize the validity of the analysis. The focus of this analysis was to provide information regarding the current tax revenue portfolio. Data from fiscal years prior to 1993 poses a significant threat to the validity of the findings due to presence of changes in tax policy that is assumed to have taken place in subsequent fiscal years.

### *Mix-Efficiency of the LFUCG Tax Portfolio – Applying the Markowitz Model*

In order to determine the degree to which LFUCG taxes have been efficient, it was the author's intent to apply the Markowitz model of portfolio theory to the five primary tax sources.

However, unexpected impediments precluded that portion of the analysis from developing and forced the author to amend the research. This unforeseen setback occurred for a couple of reasons: (1) the model and computer software used to find a series of optimal portfolios was never specified in previous research; (2) due to mathematical limitations of the author, computing the potentially optimal portfolios by hand. Nevertheless, the above research was able to identify accomplish four of the initial goals. From here, LFUCG policymakers will be able to identify the key tax sources, their dependence on each, the degree that each tax source is related, and their respective levels of volatility.

### **CONCLUSION**

The LFUCG disproportionately depends on five taxes for nearly all of its tax revenue. The employee withholdings tax, the tax source which the Urban County Government depends on most, is closely correlated to the business net profits tax and the insurance premiums tax.

Despite receiving over half of its tax revenue from the employee withholdings tax, this tax source was one of the least volatile for the period of analysis. The business net profits tax, one of the closely correlated taxes to the employee withholdings tax, was considerably more volatile during the fifteen-year period. The property tax, initially thought to be a stabilizing tax within the portfolio, was the least varied and least volatile of all the tax sources.

Regarding the need for a “mix-efficient” portfolio, the Urban County Government could change the proportions of the tax share in a manner that would improve its susceptibility to instability in tax receipts. Doing so would imply extracting more resources from tax sources that have proved less volatile over time; however, this would come at the consequence of reducing the overall size of the tax portfolio. This will indirectly reduce the level of services which the government offers the populace. For governments to levy taxes on items that historically tend to fluctuate, indirectly implies the inverse of such a policy is inferior. In addition, increasing the growth of revenues should not be the target of the application of a portfolio model, but rather its focus should lie in reducing volatility for a given rate of growth. The size of the tax base will ultimately dictate the level of tax revenue that can be extracted for any given tax source, subject to tax policy constraints.

Reducing the volatility of the tax revenue portfolio, while superficially important for ensuring that adequate revenues are collected to fund the daily operations of the governing entity, is a normative concept supported by normative rationale. Sure, citizens and policymakers would find it advantageous to reduce the relative volatility of the city’s tax portfolio. However, does this imply that exponential revenue growth is deemed desirable by those same parties? The concept of constructing a tax portfolio that lies tangent to an efficient-frontier is a normative statement of what should or ought to be. While expanding revenues might be deemed normatively desirable to policymakers, this will more than likely be viewed undesirably by taxpayers.

Finally, the application of portfolio theory fails to consider that a city might opt to substitute a portion of its tax revenue with revenue from other sources, perhaps user-fees. This method

satisfies equity concerns, as individuals opting to consume a certain activity pay for the activity; other opting to abstain from the activity will not pay and the city will not collect revenues from this transaction.

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## APPENDIX

### Correlation

The correlation coefficient  $P_{X,Y}$  between two random variables  $X$  and  $Y$  with expected values  $\mu_x$  and  $\mu_y$  and standard deviation  $\sigma_x$  and  $\sigma_y$  is defined by the following:

$$P_{X,Y} = \frac{\text{cov}(X,Y)}{\sigma_x \sigma_y} = \frac{E((X - \mu_x)(Y - \mu_y))}{\sigma_x \sigma_y}$$

Where  $E$  is the expected value operator and  $\text{cov}$  means covariance. This can also be alternatively written as:

$$\text{Corr}(X,Y) = P_{X,Y}$$

### Variance-Covariance

For a sequence of random variables  $X_1 \dots X_n$  and  $Y_1 \dots, Y_m$  of random variables, we have

$$\text{Cov} \left( \sum_{i=1}^n X_i, \sum_{j=1}^m Y_j \right) = \sum_{i=1}^n \sum_{j=1}^m \text{Cov}(X_i, Y_j).$$

For a sequence  $X_1 \dots X_n$  of random variables and constants  $a_1 \dots, a_n$ , we have

$$\text{Var} \left( \sum_{i=1}^n a_i X_i \right) = \sum_{i=1}^n a_i^2 \text{Var}(X_i) + 2 \sum_{i,j: i < j} a_i a_j \text{Cov}(X_i, X_j).$$

## Coefficient of Variation

This measure of dispersion is defined as:

$$CV = \frac{\sigma}{\mu}$$