The Linkage Between Regional Economic Indexes and Tax Bases: Evidence from New York

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Abstract
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This paper characterizes the linkage between economic activity and tax revenues for New York State and New York City. Drawing upon the methodology of Stock and Watson (1989, 1991, 1993), we use a dynamic single factor model to estimate indexes of coincident economic indicators. We also construct measures of the sales and withholding tax bases. The empirical analysis then uses vector autoregression and error correction models to examine the relationship between the indexes of economic activity and the tax base series. The results provide strong evidence that the coincident indexes contain useful information for explaining monthly growth in the tax bases; however, there is much less evidence of a statistically significant linkage from the tax bases to the coincident indexes.

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I. Introduction

Fluctuations in economic activity can potentially lead to sharp fluctuations in tax receipts, and in the current cyclical downturn many state and local governments are struggling to cope with growing budget gaps arising, in part, from weakening tax bases. This recent experience serves as a reminder about the difficulties that state and local budget officials face in their tasks. Revenue projections are generally made annually prior to the start of the fiscal year, and rely in turn on initial projections of local economic activity. In addition, the recognition of a linkage between economic activity and tax revenues belies the difficulty in quantifying the specific effect of changes in activity on revenues.

The challenging nature of the budget process becomes even more acute when one considers the nature of data constraints at the local level. Tracking activity at a high frequency over the course of the year is necessary to help alert officials (and the public) to any potential shortfall or surplus in tax revenues, and to help prepare economic and revenue projections for the upcoming fiscal year. However, local cycles can differ markedly in timing and severity from national cycles. While there are several candidate series that might serve as a reasonable measure of local area economic activity, the reliance on any one series can be problematic because of publication lags or movements related to idiosyncratic factors.

This paper offers a methodology for overcoming some of these problems and for trying to improve our understanding of high-frequency fluctuations in tax revenues. Our analysis consists of two parts that may be of separate or combined interest to readers. The first part relates to the construction of key variables of interest. In an attempt to obtain a timely and reliable measure of economic activity, we draw upon the methodology outlined in Stock and Watson (1989, 1991, 1993) to estimate separate indexes of coincident economic indicators (CEI) for New York State and New York City. These indexes are used to identify local area business cycles and conform well to conventional views of local area economic conditions. With regard to measures of state and local tax revenues, we consider three series related to the key revenue sources: the bases of the state and city sales tax and the withholding portion of the city personal income tax. These tax bases, however, are not reported directly but rather must be estimated from reported tax receipts and tax rates. Consequently, we provide details on our construction of consistent, monthly measures of these tax base series, including a discussion of the complexities arising from tax rate changes and the timing of tax payments.

The second part of the analysis focuses on statistical methods and modeling issues. We are particularly interested in assessing the linkage from the measures of state and city economic activity to the constructed tax base variables. Because the coincident indexes and tax bases tend to grow over our sample period, we examine their time series properties and investigate the possibility that they may share common trends. That is, we address the issue of cointegration between the coincident indexes and tax bases to determine if they display a long-run equilibrium relationship. As discussed, this issue is important because of its implications for the choice of estimation strategies.

To preview our empirical results, we find strong evidence that the coincident indexes contain useful information for explaining monthly growth in the tax bases. Interestingly, the form of the information appears to vary across the tax base series and involves different combinations of the (log) level and growth rate of the coincident indexes. The coincident index and sales tax base for New York State are cointegrated series, with the coincident index related to the tax base through the error correction term. While the cointegration results for the coincident index and sales tax base for New York City are somewhat weaker, the coincident index is related to the sales tax base through the error correction term as well as its past growth rates. In the case of the coincident index and the withholding tax base for New York City, there is no evidence of cointegration. However, past growth rates of the coincident index have significant explanatory content for movements in the tax base. On the other hand, we find much less evidence of a statistically significant linkage from the tax bases to the coincident indexes across the estimated models.

The results of our study should be viewed as offering preliminary evidence on the usefulness of the coincident indexes for making revenue projections. We recognize that there are limitations to a bivariate analysis, and that state and local revenue forecasters may employ alternative variables/models and may emphasize different forecasting horizons. Moreover, any evaluation of the usefulness of coincident indexes as a policy tool needs to be undertaken in a 'real time' setting. Nevertheless, it is our belief that both the method of constructing the economic activity measures and tax base variables as well as the particular models presented here are potentially relevant to revenue forecasters in a wide range of state and local economies. We also feel that establishing a statistical relationship between the coincident indexes and tax bases is a prerequisite for a more detailed analysis.

The plan of the paper is as follows. Section II describes measures of state and local economic activity and reviews the literature on the relationship between local economic activity and tax bases. Section III discusses the construction of the key variables of interest for this study—the indexes of coincident economic indicators for New York State and New York City, the sales and personal income withholding tax bases for New York City, and the sales tax base for New York State. Section IV describes the vector autoregression and error correction models used to estimate the relationship between the measures of economic activity and the various tax bases. Section V presents the model estimates and evidence from some additional empirical exercises that further evaluate the contribution of the CEI in explaining movements in the tax bases. A final section summarizes our findings and outlines some possible extensions of the work.

II. Literature Review

This section discusses previous work relating to the variables used in this analysis. The first part focuses on methodologies used to construct existing indexes of state and local economic activity. Then, we discuss studies that have looked at the issue of tax rates, tax revenues, and economic activity.

A. Coincident Indexes

Determining where an economy is in the business cycle can be difficult as the variety of individual data series used to monitor economic activity rarely give an unambiguous signal of changes in its direction and/or strength. Recognizing this problem, the U.S. Department of Commerce (DOC) developed an index of coincident economic indicators, which is a single composite measure intended to gauge current national economic activity and to help date national business cycles.[1] The measure is essentially a weighted average of four monthly data series whose movements are assumed to coincide with the business cycle--industrial production, retail sales, non-agricultural employment, and real personal income.

Because the index developed by the Department of Commerce is not based on a formal probabilistic model, Stock and Watson (1989) proposed an alternative index of coincident economic indicators that is derived within an explicit statistical framework. An attractive feature of their methodology is that the estimated coincident index incorporates the notion that business cycles are more appropriately measured by common movements across several time series.[2] The data series used by Stock and Watson are the same as those used by the DOC with the exception that they substitute aggregate employee hours for non-agricultural employment.

If state and local economic cycles were similar to national cycles, then national indexes could be used to track economic activity at sub-national levels. However, the lack of conformity of state and local economic cycles with those of the nation have made it necessary to derive separate indexes of economic activity for individual areas. The methodology developed by Stock and Watson has been used to construct monthly indexes of coincident economic indicators for a number of states, including Massachusetts, New York, New Jersey, Pennsylvania, and Delaware, as well as for New York City. Additionally, a monthly index of coincident indicators was developed earlier for the Texas economy based on the DOC methodology.[3] Both methodologies allow the index to incorporate indicators that are specific to a state or local economy. The constructed indexes also avoid the problems of relying on changes in a single indicator, such as payroll employment, or in a broad measure of activity, such as gross state product, that at the state level is reported only annually and with a considerable lag. Recently, Crone (2002) constructed indexes of coincident economic indicators for all 50 states using the Stock and Watson methodology.[4]

State and local indexes of coincident economic indicators have greatly enhanced our knowledge of local business cycles. Each index provides a timely measure of the state of the economy and can be used as a tool to date cyclical peaks and troughs in local economic activity. This cyclical dating allows for a comparison of the timing and severity of local cycles relative to those of the nation. Moreover, the state indexes of coincident indicators have been used to create indexes of leading economic indicators that can offer timely signals of an impending downturn or an emerging upturn in the state or local economy.[5]

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[1] The national coincident index is now maintained and reported by the Conference Board. See Conference Board (1996) for a detailed description of its construction.
[2] Their methodology will be discussed in more detail in the next section.
[3] See Clayton-Matthews and Stock (1998/1999) for a description of the index of coincident economic indicators for Massachusetts; Orr, Rich, and Rosen (1999) for a description of indexes for New York State, New York City, and New Jersey; Crone (1994) for a description of indexes for Pennsylvania, New Jersey, and Delaware; and Phillips (1988) for a description of the index for Texas.
[4] These indexes are available on the web at www.phil.frb.org/econ/stateindexes.
[5] For some examples see Stock and Watson (1989); Crone and Babyak (1996); and Orr, Rich, and Rosen (2001).

B. Tax Bases

The problem of estimating revenues from a given tax is as old as taxation itself. For state and local governments, this problem is especially acute, as many (including New York City and State) are required to balance their annual operating budgets. When revenues fall short of plan, gaps in the budget may develop, which can require painful emergency tax increases or spending cuts. In recent years, the state and local government sector has rapidly gone from an aggregate surplus of $32 billion (NIPA basis) in fiscal year 1999, to a deficit of over $55 billion (annual rate) in the first quarter of 2002. This large swing in the fiscal position of the sector was driven primarily by revenues that were lower than expectations (Jenny 2002).

While the problem of projecting the revenues yielded by a given tax rate structure on an unknown base is familiar to state budget officials, it is less clear what these officials can do about it. There are several dimensions to this problem that have received attention in the academic literature. There exists a large economics literature on the relationship between tax rates and tax bases, summarized in Auerbach and Hines (2002). While this research has focused primarily on federal taxes, there has been some attention to the state-local sector. Haughwout, Inman, Craig and Luce (2003) and Mark, McGuire and Papke (2000), for example, discuss the implications of tax rate changes for economic activity and tax bases in four large American cities (including New York), and Washington, D.C. In these studies, the primary interest is in tax elasticities, with concomitantly less attention paid to tax base dynamics and their connection to current economic conditions. Recent macro-econometric work has focused on the relationship between government revenues, expenditures and economic growth at the national level (Blanchard and Perotti 2003).

More closely related to the current study, a small literature has examined the relationship between local business cycles and state-local tax revenue. Sorensen, Wu and Yosha (2001) find that aggregate state and local revenues are strongly procyclical. Dye and McGuire (1991) study the variability of state sales and income tax bases, finding that these bases are quite variable across business cycles. State and local revenue estimators sometimes publicly disclose their own methods. In New York City, for example, the annual report on these methods is called *Tax Revenue Forecasting Documentation,* (New York City, Office of Management and Budget, 2003). The models described therein exploit the relationship between annual variation in revenues and changes in limited measures of economic activity, along with information on tax rates. Monthly receipts are then estimated from historical patterns.

Tax bases and coincident economic indexes have been most closely linked in work by Clayton-Matthews, Kodrzycki, and Swaine (1994) and Clayton-Matthews and Stock (1998/1999) about the Massachusetts economy. Their CEI for Massachusetts includes both the withholding tax base and the sales tax base as components, after suitable smoothing. They argue that both bases are timely measures of current economic activity. The withholding tax base is a measure of wage and salary income that is quite closely related to published BEA measures of wage and salary income for that state. In addition, the sales tax base is comparable to discontinued measures of Census retail sales.

Our study clearly draws some of its motivation from the work of Clayton-Matthews, Kodrzycki, and Swaine (1994) and Clayton-Matthews and Stock (1998/1999). It is important to note, however, that we focus on a different aspect of the linkage between measures of economic activity and tax revenues. Specifically, our study attempts to determine whether a CEI that excludes these tax base measures is useful in understanding their movements. Consequently, we treat the tax bases and coincident indexes as separate entities for purposes of analyzing their relationship. One advantage of this approach is that it eliminates the tax bases as a source of any predictive content of the coincident indexes. We also believe this approach subjects the coincident index to a more rigorous test and offers a conservative estimate of its value in explaining movements in the tax bases. To this end, we now turn to a discussion of the construction of the CEIs we will use, as well as the tax bases to which we will relate them.

III. Data Construction

This section describes the key variables of interest for this study. We initially focus on the estimation of the index of coincident economic indicators (CEI) using a dynamic single factor model. We then provide details on the construction of the sales and withholding tax bases.

A. The Coincident Index

While a number of alternative methodologies have been proposed for constructing a coincident index, we will apply the model-based approach developed and refined by Stock and Watson (1989, 1991, 1993). In their framework, Stock and Watson view the observed movement in a set of coincident variables as reflecting the influence of two factors: an unobserved component that is common to all series, plus an unobserved idiosyncratic component that is unique to each series. Because the “state of the economy” is widely viewed and understood to have a shared influence across different measures of economic activity, the CEI is defined as the estimated common component.

These ideas are formalized in equations (1)-(3) of the following dynamic single factor model:

$$\Delta X_t = \beta + \gamma(L)\Delta S_t + \mu_t \quad (1)$$

$$D(L)\mu_t = \varepsilon_t \quad (2)$$

$$\phi(L)\Delta S_t = \delta + \eta_t \quad (3)$$

$$\Delta CEI_t = a + b\Delta S_t \quad (4)$$

where X_t is an (n x 1) vector of the logarithms (or levels) of coincident indicators, L denotes the lag operator, Δ denotes the difference operator $(1-L)$, and $\phi(L)$, $\gamma(L)$ and $D(L)$ are respectively scalar, vector, and matrix lag polynomials. Equation (1) relates the growth (or change) in the coincident variables to the growth in the index representing the state of the economy, ΔS_t, and an n-dimensional component, μ_t, that represents idiosyncratic movements of each coincident indicator.[6] Equation (2) describes the behavior of the idiosyncratic components which are stationary, mean zero, autoregressive processes. The dynamic aspect of the model stems from equation (3) where the growth in the state of the economy is assumed to follow a stationary autoregressive process. The idiosyncratic factors and the growth of the index are also assumed to be uncorrelated with each other at all leads and lags, which restricts S_t to be the only source for co-movements of the coincident indicators. Thus, the n + 1 disturbances $(\varepsilon_{1t},\ldots,\varepsilon_{nt},\eta_t)$ are mutually and serially uncorrelated with covariance matrix $\Sigma = diag[\sigma_1^2,\ldots,\sigma_n^2,\sigma_\eta^2]$.

Identification of the model requires the imposition of additional restrictions. These restrictions include stipulating that ΔS_t enters at least one of the variables in equation (1) only contemporaneously, and setting σ_η^2 equal to unity.[7] Estimation of the system of equations (1)-(3) can then proceed by applying the Kalman filter and using a quasi-maximum likelihood procedure. Because the variables in (1) will be

[6] As shown, equation (1) is general enough to allow the coincident indicators to respond contemporaneously with the state of the economy, to lead the state of the economy, or to lag the state of the economy.

[7] The restriction that $\gamma(L) = \gamma_0$ for at least one of the variables in equation (1) fixes the timing of the index.

normalized by subtracting their mean and dividing by their standard deviation, the parameters β and δ can be concentrated out of the likelihood function. Further details on the estimation are provided in Stock and Watson (1989, 1991, 1993) and Clayton-Matthews and Stock (1998/1999).

A key output of the estimation procedure is the index S_t. There are two important issues related to its construction. First, it is possible to produce alternative estimates of the index based on different information considerations. That is, one can obtain a 'real-time' estimate based only on currently available information, $S_{t|t}$, or a 'retrospective' assessment based on the full-sample information set, $S_{t|T}$. For our study, we will employ the full information version of the index. This choice is motivated by our interest in deriving the most reliable historical series for the empirical analysis.[8] Second, the standardization of the coincident indicators and the nature of the identification strategy result in a driftless index with a unit-variance shock. In order to incorporate a trend into the index as well as to provide a basis for meaningful comparisons across different localities, we will use data on real wage and salary income to choose values for the first two moments of the index. That is, we select the coefficients a and b in equation (4) so that the CEI for New York State (New York City) has a trend growth rate and a variance around the trend equal to those of real wage and salary income for New York State (New York City). Details on this procedure are provided in Clayton-Matthews and Stock (1998/1999).

Before turning to a discussion of the various tax bases, it is instructive to briefly mention some of the attractive features of the Stock/Watson methodology for the estimation of the coincident index. One attractive feature of the model is that it offers a plausible specification for capturing fluctuations in activity associated with the business cycle. In addition, the coincident index generated from the dynamic single factor model can be shown to be a weighted average of current and past values of the coincident indicators, where the weights are determined from the model. This contrasts with alternative methodologies in which the index only reflects the current value of the coincident indicators and where the weights are determined on an *ad hoc* basis.[9] Last, the use of the Kalman filter for model estimation allows us to consider data that may be of mixed frequency and that may contain missing observations. Consequently, we are not restricted

[8] We also compared the estimates of $S_{t|T}$ to $S_{t|t}$ and found they were broadly similar.

in our choice of coincident indicators and we do not need to be concerned about interpolating or time averaging some of the series.

B. The Tax Bases[10]

The tax systems of New York City and State are complex, with many different taxes levied on various bases. Here, we study three taxes for which we are able to obtain monthly revenue and rate data: the New York State and City general sales and use taxes, and the New York City withheld personal income tax. We describe salient features of these taxes and their bases below.[11] Our base estimates for the three taxes make use of the fundamental tax identity $L_t = \tau_t B_t$, where L represents tax liabilities generated by a given tax, τ is the average tax rate, B is the tax base and t indexes the time period. From this expression, it follows (again, identically) that $B_t = L_t / \tau_t$. While this identity is simple in principle, its implementation requires some attention to the complexities of the taxes we are examining. Several factors complicate the construction of our tax bases.

Sales and use taxes. The New York State sales and use tax is a broad-based tax deriving significant revenues from many sectors of the economy other than retail trade, which comprises just 55.9% of the base. The rest of the tax base reflects services, electricity and gas sales, purchases made by manufacturers, communications and construction firms, and wholesale purchases. The base for the tax is thus broader than its name might imply.

New York State instituted a general sales and use tax in August 1965, at a rate of 2%; the rate was raised in 1969 (to 3%) and 1971 (to 4%), where it remained until 2003.[12] New York City's general sales rate of 4% was instituted in July 1974, having been raised from its previous 3% level.[13] Thus at both the

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[9] Such methodologies include those adopted by the U.S. Bureau of Economic Analysis and The Conference Board.
[10] The Appendix contains more information on the taxes that we describe in this section.
[11] Haughwout, Inman, Craig and Luce (2003) provides a more complete description of New York City's revenue system; details on New York State taxes may be found in *Handbook of New York State and Local Taxes*, NYS Office of Tax Policy Analysis (2003).
[12] The changes to the tax structures in New York State and New York City introduced in 2003 lie outside our sample period. See the Appendix for a discussion of the current sales and income tax rates.
[13] Since 1981, the effective sales and use tax rate in New York City has been 8.25%, reflecting the city and state taxes, as well as an additional tax of ¼% for the benefit of the Metropolitan Commuter Transport District (MCTD). The revenues generated by the MCTD component of the tax are excluded from our analysis.

state and city level, average (=marginal) sales tax rates have remained constant over our sample period (January 1978 to March 2002), easing the calculation of the base.[14]

Vendors, depending on the size of their taxable revenues, must file quarterly or monthly sales tax returns with New York State, which administers both the state and local portions of the sales and use tax. In addition, vendors with annual sales tax liability in excess of $500,000 (at 2003 rates) are now required to transfer payments electronically.[15] Reported monthly sales tax receipts thus reflect sales activity with relatively short lags.

A perhaps more serious concern with our measure of the sales tax base in New York City and State is the policy of temporary exemptions for clothing and footwear. Weeklong sales tax holidays for clothing and footwear valued at less than $500 were instituted in January 1997, September 1997 and January 1998. Beginning December 1, 1999, clothing and footwear valued at less than $110 were exempted from the tax.[16] These exemptions have the potential to introduce monthly variations to the tax base during the months in question. There is additional potential for the holiday and permanent exemption periods to affect this relationship in surrounding months, as consumers have incentives to concentrate their purchases of clothing and footwear during the low tax periods. Our simple measure of the base does not adjust for these fluctuations in the effective tax rate on clothing consumption; we leave complete analysis of this issue for future study.

Income tax. New York City's personal income tax, which was instituted in 1965, has a progressive rate structure, with the marginal rates at the end of our sample period ranging from 2.907% to 3.648%. The rate schedule has changed several times over the course of our sample period for the New York City income tax (October 1982 to December 2002).

The City's income tax follows the state tax in its definition of gross income, meaning that it includes both earned and unearned income, as well as the proceeds from such financial transactions as the exercise of stock options and sales of businesses. Taxable income is determined, in part, by individuals' deductions

[14] While our data on sales tax bases extends back to the origins of the state tax in 1965, the early years of the reported tax revenues exhibit significant anomalies. We thus limit our analysis of the base to the period 1978 to 2002.

[15] *Handbook of New York State and Local Taxes*, NYS Office of Tax Policy Analysis (2003).

[16] *Handbook of New York State and Local Taxes*, NYS Office of Tax Policy Analysis (2003). The changes to the tax rates in 2003 eliminated the tax exemption on sales of clothing and footwear valued at less than $110.

and credits, which depend on such variables as the sources and disposition of gross income, marital status and family structure. In addition, taxpayers have some control over their liabilities, as they can time receipts, adjust withholding, or shelter income from taxes.

These features of the tax raise several issues related to the construction of the base, its timing and its relationship with current economic activity. First, they make the relationship between the tax rate and its underlying base more complex, since the average tax rate (τ) is determined by the level of individuals' incomes, deductions and credits. Second, tax liabilities accrued on some of these bases (particularly unearned income sources) are typically paid at specific dates throughout the year, particularly estimated tax filing dates and the April 15 annual filing deadline. Finally, the components of the base that include capital gains and other financial transactions may be only indirectly related to measures of current state or local economic activity.

Our focus on withholding revenues mitigates the last two problems. All employers in New York State are required to submit personal income taxes within five business days after each payroll; large employers must transfer funds electronically.[17] Thus monthly revenues primarily reflect liabilities associated with very recent wage and salary disbursements, reducing concerns about both the timing of payments generated by other sources of income and their connection with current activity. However, the withholding base also includes bonus payments; see the Appendix for more details. Our focus on withholding also allows us to use information from the city's withholding tables, which report both rates of withholding and the exact dates at which rate changes are put into effect.

The fact that the city's income tax has a progressive rate structure means that we must calculate an average rate on a monthly frequency. In order to do so, we first calculate an annual average rate by calculating the annual ratio of personal income tax revenues to aggregate personal income for New York City. We then calculate the ratio of this average tax rate to the top marginal rate over the entire time period. This ratio is 0.322. That is to say, at an annual frequency, the average rate on income is approximately one third of the top marginal rate. We use this relationship to predict the monthly average income tax rate, using the top rate in the monthly withholding schedule.

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[17] *Handbook of New York State and Local Taxes*, NYS Office of Tax Policy Analysis (2003).

Of course, the withholding portion of the personal income tax is considerably easier to predict than, for example, the portion attributable to taxable capital gains realizations. Although the presence of bonus payments in the former weakens its connection with current local activity, it is still dominated by wages and salaries earned by city residents. The latter, on the other hand, will depend fundamentally on the time path of asset values and other variables that are only indirectly related to the current state of the City's economy. Nonetheless, even the withholding base exhibits significant volatility over time, and improving predictions of it will prove beneficial to state and local officials responsible for revenue estimates.

We do not wish to oversell our tax base measures. In spite of our adjustments, it is likely that we measure the bases with some error that will serve to weaken their relationship with current activity. In particular, our estimates of changes in the base of the withheld personal income tax include both changes due to economic fluctuations and those attributable to such behavior as changes in deductions for withholding. Revenue estimators will presumably have more accurate measures of historical bases at their disposal, allowing them to estimate tighter relationships between tax bases and current activity than our limited information allows. Consequently, our goal in the current analysis is to study whether our measures of current activity will be significantly related to relatively simple measures of tax bases.

C. The Estimated CEI , the Sales Tax Base, and the Withholding Tax Base

The selection of the coincident variables for the New York State CEI and the New York City CEI follows from the previous analysis of Orr, Rich and Rosen (1999). For both New York State and New York City we use information on four series: non-farm payroll employment, the unemployment rate, average weekly hours worked in manufacturing, and real earnings (wages and salaries).[18] The employment, unemployment, and weekly hours worked series are made available monthly by the U.S. Bureau of Labor Statistics in cooperation with the New York State Department of Labor. The data for each month are normally reported with a roughly three-week lag after the end of the reference month. Nominal wage and salary earnings are released quarterly by the U.S. Department of Commerce (New York State)

[18] The components of our index differ somewhat from those used to compute the national coincident index. Specifically, our index uses average weekly hours worked in manufacturing and the unemployment rate in place of the national index's measures of industrial production and manufacturing and retail sales. The latter two variables are not available at the state or local level. The four variables used to compute the New York State and New York City indexes are also used to compute our New Jersey index and several other state coincident indexes. (See the Federal Reserve Bank of Philadelphia website address www.phil.frb.org/econ/stateindexes/index.html for additional examples.)

and the New York State Department of Labor (New York City) with a lag of approximately seven months. We deflate these earnings measures by the national CPI to arrive at real, or inflation-adjusted, earnings.[19] In the case of the wage and salary earnings series, the publication lag results in observations that are missing for the two most recent quarters. As previously noted, however, the Kalman filter allows us to estimate the index through the time period for which the monthly series are available.

Because the coincident variables and tax data contain considerable high frequency noise and seasonal components, we filtered each variable using an adaptation of the U.S. Bureau of the Census X-11 procedure.[20] As noted by Clayton-Matthews and Stock (1998/1999), the Kalman filter in principle can handle issues related to smoothing and seasonal adjustment of the data. However, this would require consideration of high orders for the lag polynomials $\gamma(L)$ and $D(L)$ in equations (1) and (2). Consequently, we elected to filter the data for reasons of parsimony and practicality.

Table 1 presents the estimated coincident index model for New York State and New York City, respectively, from October 1965 – December 2002. We applied a diagnostic testing procedure discussed in Stock and Watson (1989, 1991) to determine the appropriate specification for each model. As shown, the state of the economy affects payroll employment, the unemployment rate and real earnings contemporaneously, while there is both a contemporaneous and lagged effect in the case of average weekly hours in manufacturing. In addition, there is strong evidence of autoregression in the idiosyncratic components of the coincident variables. It is also important to note that the estimated values of the ϕ's in each model suggest a very high degree of persistence in the economy. This finding is similar to the results reported by Clayton-Matthews and Stock (1998/1999) for their estimated coincident index for Massachusetts and suggests that shocks to the growth rate of the state of the economy diminish slowly over time.

The upper and lower panels of Figure 1 plot the estimated coincident indexes for New York State and New York City, respectively. The indexes closely reflect the conventional wisdom about the history of business cycles in New York State and New York City. The upper panel shows the timing, duration, and severity of business cycles in New York State (shaded regions) between 1965 and the end of 2002 and, for

[19] The price index is the CPI-U which measures the change in the price of a typical urban consumer's market basket of out-of-pocket expenditures.

comparison, the peak and trough dates (vertical bars) of the national business cycles. The chart identifies six downturns in the state's economy starting with the cyclical peak in activity in late 1969. The two downturns in the 1970s began slightly earlier but lasted almost a year longer than the corresponding national cycles, while the state's declines in 1980 and 1982 roughly coincided with the national recessions.

A stark difference between the downturns in New York State and the nation occurred at the end of the 1980s. While the state's economy peaked in early 1989 and declined through late 1992, the national recession was wholly contained within the 1990-1991 period. Moreover, the almost 15 percent decline in state economic activity in that recession exceeded the declines recorded in each of the earlier four recessions. The relatively strong job and income growth in the state in the second half of the 1990's is reflected in the sharp increase in the CEI through the end of 2000. The latest downturn began in December 2000, three months prior to the beginning of the national recession and, notably, nine months before the September 11 attack on the World Trade Center. The relatively rapid decline in 2001 moderated in 2002, though as of the end of the year the CEI had yet to indicate a recovery in economic activity.

The bottom panel identifies the four downturns that the New York City economy has experienced following the peak in activity in late 1969. The timing of the city's downturns has differed markedly from that of the nation and the state. The decline in activity that lasted through 1976 spanned two national recessions and reflected, in part, employment and real earnings declines due to continuing Wall Street weakness and the burgeoning loss of manufacturing and construction jobs. The period also saw the city endure a severe fiscal crisis, and economic activity did not bottom out until more than a year after the national recession had ended. Activity in the city barely slowed during the national recession in 1980 and slowed only mildly during the recession of 1981-1982. In contrast, weakness emanating from the financial sector helped to make the city's 1989-1992 downturn substantially longer than the nation's. The city saw remarkable growth in activity for most of the 1990s as the financial sector prospered and a variety of service industries, including new media and motion pictures, developed and expanded. The current downturn began in February 2001, one month prior to the national recession, and activity fell sharply throughout the year. The rate of decline slowed during 2002 though activity had not leveled off by the end of the year.

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[20] This procedure is available as a routine in SAS.

Figures 2-3 display the CEIs and our estimates of the sales tax bases for New York State and New York City, respectively, for the period January 1978-December 2002. Figure 4 displays the CEI and our estimates of the withholding tax base for New York City for the period January 1982-December 2002. The tax base series were each deflated by the national CPI to arrive at real magnitudes. While there is significant month-to-month noise in the tax bases, their low frequency movements seem to track conditions in the state and local economies as measured by the relevant CEI. The state sales and use tax base (Figure 2) generally rises in real terms during expansions as measured by the state CEI; it declines in each of the downturns measured by the CEI. One possible exception to this general finding is the late 1970s, when the state sales tax base declined in spite of a moderately strengthening state economy.

The City's real sales tax base (Figure 3) also tends to follow current conditions as measured by the City CEI. After remaining relatively flat during the late 1970s and early 1980s, the base rises strongly through the late 1980s, falls during the local 1989-92 downturn, and recommences its increase after that. The real sales tax base in the City reached a cyclical peak in early 2001, as the recent local downturn was getting underway.

The City's personal income withholding tax base (Figure 4) also follows the general pattern of the CEI, but while its growth slows during local downturns, its cyclical behavior is less pronounced than that of the City sales and use tax. Even during the prolonged local downturn in 1989-92, the portion of the City's income tax base that is subject to withholding is essentially flat; this, however, contrasts with strong growth before and after that event. Our measure of the base peaks in February 2001, the same month as the peak in the City CEI.

IV. Estimation Strategy

Because the level of the coincident indexes and tax bases display clear evidence of an upward trend, a researcher might simply consider differencing the data before proceeding with the empirical analysis. This approach would then lend itself to specifying a vector autoregression (VAR) model and estimating the following relation between the variables in terms of their growth rates:

$$\Delta Tax\ Base_t = \alpha_1 + \sum_i \theta_i^{11}(\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12}(\Delta CEI_{t-i}) + \varepsilon_{1t}$$
$$\Delta CEI_t = \alpha_2 + \sum_i \theta_i^{21}(\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{22}(\Delta CEI_{t-i}) + \varepsilon_{2t} \quad (5)$$

where $Tax\ Base_t$ and CEI_t denote, respectively, the logarithm of the tax base and the logarithm of the CEI at time t, and *i* denotes lag length. The VAR model has gained widespread popularity because it is particularly convenient for analyzing the dynamics of economic systems and forecasting.

While the estimation of a VAR model is relatively straightforward, a reexamination of Figures 2-4 suggests that this modeling strategy might be inappropriate. Specifically, some of the series pairings appear to display evidence of a long-run relationship in the sense that they do not drift too far apart over time. In particular, the NY State sales tax base and CEI appear to move together, as do the NY City sales tax base and CEI. As discussed shortly, the importance of this consideration is that it has implications for model estimation. If there is a long-run relationship between the series, then ignoring this feature of the data and estimating the series as a VAR in first differences entails a misspecification error.

The issue of a long-run relationship between the tax base and CEI relates to an interesting class of models known as cointegrating processes. Underlying this concept is the idea that some trending time series may be characterized as integrated processes, but that a particular linear combination of the series may be stationary. If such a property holds, then the series are cointegrated. For our purposes, the concern is whether each tax base and the CEI are integrated of order 1, while there exists a linear combination that is integrated of order 0.[21] Under this situation, the appropriate representation for the series would be given by the following vector error-correction model (VECM):

$$\Delta Tax\ Base_t = \alpha_1 + \gamma_1(Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{11}(\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12}(\Delta CEI_{t-i}) + \varepsilon_{1t}$$
$$\Delta CEI_t = \alpha_2 + \gamma_2(Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{21}(\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{22}(\Delta CEI_{t-i}) + \varepsilon_{2t} \quad (6)$$

The key aspect of the VECM is that the time paths for the tax base and CEI are additionally influenced by the extent of any deviation from their long-run equilibrium represented by $(Tax\ Base - \delta - \rho CEI)$. The VECM essentially augments the VAR model in (5) with a lagged value of an error correction term to capture the cointegrating relationship.

[21] A process is said to be integrated of order 0 (I(0)) if it is a (strictly) stationary process whose long-run variance is finite and positive. A process is said to be integrated of order *d* (I(*d*)) if its *d*-th difference is

To analyze the time series properties of the data and to determine the appropriate model specification, we conduct unit root tests as well as cointegration tests. The augmented Dickey-Fuller (1979) unit root tests are of the form:

$$Tax\ Base_t = \alpha + \beta(Trend_t) + \phi(Tax\ Base_{t-1}) + \sum_i \zeta_i(\Delta Tax\ Base_{t-i}) + \varepsilon_t \tag{7}$$

$$CEI_t = \alpha + \beta(Trend_t) + \phi(CEI_{t-1}) + \sum_i \zeta_i(\Delta CEI_{t-i}) + \varepsilon_t \tag{8}$$

where $Trend_t$ is a linear time trend. The test for the presence of a unit root in the series is a test of the null hypothesis that $\phi = 1$. The lagged first differences of the variables control for serial correlation in the regression residuals, with the number of lags selected by the Bayesian Information Criterion (BIC) rule.

For the cointegration tests, we apply the procedure developed by Johansen (1988) that relies heavily on the relationship between the rank of a matrix and its characteristic roots. This method involves the estimation of a VAR for the series in first differences along with the lagged level of the variables in period $t-1$:

$$\Delta y_t = A_0 + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta y_{t-i} + \varepsilon_t \tag{9}$$

where $y_t = (Tax\ Base_t, CEI_t)'$.[22] As discussed by Johansen, the number of distinct cointegrating vectors equals the rank of Π which is equal to the number of its characteristic roots that differ from zero. The test for the number of characteristic roots that are significantly different from zero can be conducted using the following two test statistics:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i) \tag{10}$$

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1}) \tag{11}$$

where $\hat{\lambda}_i$ is the estimated values of the characteristic roots obtained from the estimated Π matrix in equation (9) and T denotes the number of usable observations. The first statistic tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative. The second statistic tests the null hypothesis that the number of cointegrating vectors is r against the alternative

I(0). An I(1) process is also called a unit root process because its first difference is stationary. See Hamilton (1994) for a much more detailed discussion of these statistical concepts.

[22] It should be noted that estimation of equation (9) involves the imposition of cross-equation restrictions on the Π matrix.

of $r+1$ cointegrating vectors. If the estimated value of the characteristic root is close to zero, then $\ln(1-\lambda_i)$ will be close to zero as will the value of the λ_{trace} and $\lambda_{\max}$ statistics.

If there is no evidence of cointegration between the tax base and the CEI, then we will proceed to estimate the VAR system described in equation (5). On the other hand, evidence in support of a single cointegrating relationship between the tax base and the CEI will lead us to estimate the VECM system described in equation (6). While several strategies have been proposed for estimation of the VECM, we will employ the maximum likelihood (ML) procedure proposed by Johansen (1988, 1991).

The VAR and VECM frameworks are attractive for addressing a number of important issues. For example, we can use the models to gain insights into the dynamic relationship between the variables and test for their significance in specific equations of interest. In the case of the VECM, the speed of adjustment parameters γ_1 and γ_2 relate departures from long-run equilibrium in the cointegrating relationship to subsequent changes in the (log) levels of the tax base and CEI. An examination of these parameters therefore can be informative about both the magnitude and direction of adjustment of the variables toward long-run equilibrium. Last, the design of the models is useful for forecasting purposes because the specification of the system ensures a consistency between the generated future values of the variables across the equations.

V. Empirical Results

Our data for the sales tax base-CEI relationship cover the period January 1978 – March 2002, while the data for the withholding tax base-CEI relationship cover the period October 1982 – December 2002. Because each series is characterized by a trend, we initially investigated their stationarity properties and conducted augmented Dickey-Fuller unit root tests. The results generally supported the hypothesis that the coincident indexes and tax bases are integrated of order one. That is, the tests failed to reject the null hypothesis of a unit root for the (log) level of the series, but rejected the null hypothesis of a unit root for the change in the series.[23] It is interesting to note that while the growth rate of the coincident index is a stationary process by construction, the unit root tests only provided a marginal rejection of the null hypothesis of nonstationarity for the series. This outcome likely reflects a combination of the high degree of persistence in the series previously documented in Table 1 and the known low power of the augmented Dickey-Fuller unit root tests.

In light of the results indicating that the coincident indexes and tax bases are I(1) processes, Table 2 presents the tests for cointegration using the Johansen (1988, 1991) procedure.[24] As shown by the value of the test statistics, we find varying evidence of cointegration across the coincident indexes and tax bases. For the NY State sales tax base and CEI, the trace test and maximum characteristic root test indicate one cointegrating relationship at both the 5% and 1% significance levels. For the NY City withholding tax base and CEI, however, we find no evidence of cointegration. In the case of the NY City sales tax base and CEI, there is somewhat conflicting evidence. While both test statistics indicate one cointegrating relationship at the 1% significance level, they cannot reject the hypothesis of two cointegrating relationships using a 5% significance level.

In an attempt to clarify these results, we turned to an alternative methodology and applied the residual-based cointegration test developed by Engle and Granger (1987). This testing procedure consists of two stages. The first stage uses ordinary least squares to estimate the following relationship:

$$Tax\ Base_t = \delta + \rho(CEI_t) + \eta_t \tag{12}$$

The second stage essentially amounts to a unit root test of the residuals from the first stage regression:

$$\hat{\eta}_t = \psi_0 \hat{\eta}_{t-1} + \sum_i \psi_i (\Delta \hat{\eta}_{t-i}) + \upsilon_t \tag{13}$$

For the above test, cointegration is taken as the alternative hypothesis.

The bottom panel of Table 2 presents the results of the residual-based augmented Dickey-Fuller tests for cointegration. The lag length of the first differences of the residuals was again selected by the BIC. For the NY City sales tax base and CEI, we are now able to uncover some weak evidence of a long-run equilibrium relationship between the series as the value of the test statistic rejects the null hypothesis of no cointegration at the 10% significance level. The results also confirm the previous conclusions about the cointegrating relationship between the NY State sales tax base and CEI as well as the NY City withholding

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[23] The Dickey-Fuller unit root tests for the (log) level of the series are based on the regression specified in equations (7) and (8). An additional difference is taken (except for the time index) for the unit root tests of the change in the (log) level of the series. These results are not reported to conserve space.

[24] As shown in equation (9), the testing procedure requires the selection of a lag length of the first differenced terms. The lag length was again selected by the BIC.

tax base and CEI. Taken together, the findings in Table 2 provide the rationale for our estimation of a VECM to analyze the relationship between the CEI and sales tax base series for New York State and New York City.[25] In the case of the CEI and withholding tax base for New York City, the findings indicate that we should employ a VAR framework to analyze their relationship

The choice of modeling strategies would appear to be consistent with the nature of the relationships suggested from a visual inspection of the CEI-tax base series depicted in Figures 2-4. Moreover, the cointegration results comport well with the nature of the tax bases we are modeling. The State and City sales tax bases include contributions from the current purchases of many sectors of the economy, as indicated in Section IIIB and Appendix charts 1 and 2. We would anticipate *a priori* that the aggregate purchases of these sectors would generally move in tandem with the current level of economic activity. The withheld income tax base is somewhat more complex, however. In addition to its dependence on current wages and salaries, this series is also influenced by bonus payments (see the Appendix). Because a large share of bonus income is paid by firms in the financial service sector, these payments may reflect factors that bear little connection to the performance of the city economy. In addition, taxpayers may adjust their withholding to reflect changes in income that is not subject to withholding, thereby damping the cyclical pattern in the series. These features of the withheld income base will also serve to weaken its connection to the CEI, which measures current economic activity. This is precisely the conclusion that our cointegration results suggest.

Tables 3-4 report the results from estimation of the VECM for the sales tax base and coincident index for New York State and New York City, respectively. Table 5 reports the results from estimation of the VAR for the withholding tax base and coincident index for New York City. The lag length for the VECM and VAR models was again selected by the BIC. We also examined the roots of the characteristic polynomial for the estimated VECM and VAR models and found that they satisfied the stability condition.[26]

Several interesting findings emerge from the empirical analysis. For example, the explained variation in the one-month growth rate of the tax base across the models is not inconsequential and ranges

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[25] To preview the empirical results, the error correction term is statistically significant in the tax base equation for the New York City VECM. We view this evidence as additional support for the specification.

from approximately 0.50 to 0.60. While pre-estimation filtering removes some noise from the tax base series and consequently should help strengthen the estimated relationships, the fit of the equations nevertheless exceeded our expectations based on the high frequency of the data. Not surprisingly, there is a strong inertial component to each equation with lagged values of the dependent variable being highly statistically significant. In addition, an informal examination of the estimated long-run equilibrium relationship between the sales tax base and CEI for New York State:

$$Tax\ Base = 14.58 + 0.79CEI \tag{14}$$

and for New York City:

$$Tax\ Base = 14.50 + 0.62CEI \tag{15}$$

would suggest they are broadly comparable.

The results also reveal that the relationship between the coincident indexes and tax bases varies considerably across the estimated system of equations. With regard to the VECMs, the error-correction term is highly significant in both sales tax base equations as well as in the CEI equation for New York State. In addition, lagged growth rates of the CEI have some marginal explanatory power for the New York City sales tax base.

A closer inspection of the reported estimates for γ_1 and γ_2 offers additional insight into the dynamic relationship between the sales tax bases and the CEIs. For the New York State VECM, the sign and significance of the coefficients indicates that both the sales tax base and the CEI adjust to eliminate any deviations from long-run equilibrium. Specifically, if the values of the series were such that they were above (below) their long-run equilibrium in one month, then there would be downward (upward) pressure on the growth of the sales tax base and upward (downward) pressure on the growth of the CEI in the subsequent month. The coefficients also suggest a much larger response on the part of the sales tax base. For the New York City VECM, the statistical insignificance of the error correction term implies that it is the sales tax base alone that does all the correction to eliminate any deviations from long-run equilibrium. Consequently, a positive value of the error correction term would only be expected to lead to a slowing in the growth of the sales tax base in the following month. However, the magnitude of the predicted response is similar to that for New York State.

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[26] For the VECM, one root was equal to unity and the others lay inside the unit circle. For the VAR, all the

In light of the documented statistical significance of the error correction terms, we thought it would be instructive to examine the estimated gap, $(Tax\ Base - \hat{\delta} - \hat{\rho}CEI)$, in more detail. As previously discussed, this term captures the deviation of the sales tax base and CEI from long-run equilibrium. The upper and lower panels of Figure 5 plot, respectively, the estimated gap for the New York State and New York City VECMs. Because the series contain considerable high frequency noise, they were smoothed using a centered 3-month moving average.

As shown, the estimated gaps display some interesting features. If one were to treat the downturns in New York State in 1980 and 1982 as a single episode, then there is a tendency for the series to turn negative during recessions. Similarly, there is a tendency for the series to turn positive during expansions. However, there is not enough regularity in the patterns to suggest that either series can serve as a reliable indicator for business cycle turning points. While a negative value of the gap has coincided with the onset of recessions, there are other episodes in which this occurrence has substantially lagged a downturn or been altogether unrelated to a downturn. The evidence of a link between a positive value for the gap and the incidence of a recovery is even less compelling. Because the gap essentially reflects a ratio, Figure 5 would appear to depict a lack of consistency in the cyclical behavior of the relative movements in the sales tax base and CEI over the sample period.

With regard to the VAR, the estimation results again reveal evidence of a linkage from the coincident index to the tax base. While the cointegration tests provide no evidence of a long-run equilibrium relationship between the levels of the CEI and withholding tax base for New York City, past growth rates of the CEI are highly significant in the tax base equation in the VAR. A test of the null hypothesis that the coefficients on the two lagged CEI growth rates are jointly equal to zero is rejected at the 5% significance level.

While the linkage from the tax bases to the coincident indexes is not a central focus of our study, it is nevertheless important to note that the tax bases generally have little explanatory content for the monthly growth rates of the CEI. The only exception is for the New York State VECM where the error correction

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roots lay inside the unit circle.

term was significant in the CEI equation. Consequently, there is an absence of Granger causality from the tax bases to the CEI for both the VECM and VAR models for New York City.[27]

To evaluate the predictive content of the CEI for the tax bases in a little more detail, we conducted two empirical exercises. First, we excluded the CEI from the vector autoregression and error correction models and proceeded to estimate the following autoregressive (AR) model for the tax bases:

$$\Delta Tax\ Base_t = \alpha_1 + \sum_i \theta_i^{11}(\Delta Tax\ Base_{t-i}) + \varepsilon_t \tag{16}$$

Second, we augmented the AR models for the tax bases to include the monthly coincident indicator variables:[28]

$$\Delta Tax\ Base_t = \alpha_1 + \sum_i \theta_i^{11}(\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12}(\Delta Coincident\ Indicator_{t-i}) + \varepsilon_t \tag{17}$$

We considered the coincident indicator variables separately as well as in conjunction with each other. For purposes of comparability with the results reported in Tables 3-5, smoothed values of the coincident indicator variables were employed and the lag lengths in equations (16) and (17) were set equal to 2.

For the univariate specification in equation (16), the R^2 's were 0.455, 0.555, and 0.486 for the NY State sales tax base, NY City sales tax base and the NY City withholding tax base regressions, respectively. This represents a decline in the fit of the models that ranges from 5% for the NY City withholding tax base to 14% for the NY State sales tax base. When we included the coincident indicator variables as additional regressors for the AR(2) models in equation (17), the lagged growth rates of the tax bases remained highly significant. However, the estimated effects of the coincident indicator variables were both individually and jointly statistically insignificant in all but one case.[29]

Taken together, the evidence suggests that our estimated coincident indexes contain additional information that is useful for explaining the behavior of tax base series for New York State and New York City. Interestingly, the nature of the information involves different combinations of the level and growth rates of the CEI across the models. Moreover, the coincident indexes appear to have the added advantage of

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[27] Some caution should be exercised in drawing conclusions from this result about the usefulness of the tax base series as coincident variables. The lack of any correlation may simply reflect the very high degree of persistence of the CEI growth rates. Moreover, any evaluation of tax bases as coincident indicators needs to be based on a more formal analysis along the lines of Clayton-Matthew and Stock (1998/99) in which they directly incorporate the series in a dynamic single factor, multiple indicator model.

[28] Because the data frequency of the real earnings (wages and salaries) series is quarterly, this variable was excluded from this analysis.

being able to extract and combine information from the coincident indicator variables that may not be evident when the series are considered separately from each other.

VI. Conclusion

This article seeks to characterize and quantify the linkage between local economic activity and various tax bases in New York State and New York City. While it is generally recognized that the growth in the tax base, from which tax revenues are derived, is driven in part by the growth in economic activity, any attempt to quantify the relationship requires meaningful measures of these magnitudes at the local level. Because local economic cycles can differ from those of the nation, indexes of coincident economic indicators were constructed separately for the state and the city. These indexes provide us with monthly, real-time series on activity that allow us to gauge the current state of the local economy. In addition, three tax bases were constructed from information on tax receipts and tax rates. Specifically, we focused on the monthly sales and personal income withholding tax bases in New York City and the monthly sales tax base in New York State. The construction of these variables involved taking account of the complexities of the timing of receipt of the revenues and changes over time in the various tax rates.

The key result of our empirical analysis concerns the finding of a significant relationship between local economic conditions and the three tax bases. That is, movements in the indexes of coincident economic indicators contain information relevant for explaining subsequent movements in the sales and income withholding tax bases in New York City and for the sales tax base in New York State. Moreover, tracking the real-time changes in local economic conditions using these indexes can provide policymakers and other interested parties with actual estimates of changes to the tax base and thus to tax revenues.

In light of the fact that budgets at the state and local level are generally prepared annually, one extension of this work would be to forecast local economic conditions over a one-year horizon in order to predict the tax base for the upcoming year. Potential improvements to revenue projections could come about both because the indexes provide a useful measure of the performance of the local economy and because that component of the revenue change that is linked to local economic activity is better measured.

[29] The one exception was when we included the two lagged values of the NY City unemployment rate in the sales tax base regression.

Table 1

Estimated Coincident Index Model

$$\Delta X_t = \beta + \gamma(L)\Delta S_t + \mu_t$$
$$D(L)\mu_t = \varepsilon_t$$
$$\phi(L)\Delta S_t = \delta + \eta_t$$

New York State
Estimation Period: 1965:10 – 2002:12

Parameter	Payroll Employment	Average Weekly Hours in Manufacturing	Unemployment Rate	Real Wages and Salaries
γ_0	0.3238 (0.0452)	0.5245 (0.0893)	-0.2034 (0.0309)	0.0273 (0.0056)
γ_1	----	-0.5022 (0.0906)	----	----
d_1	-0.2523 (0.0693)	-0.4081 (0.0888)	-0.3151 (0.0515)	-0.0695 (0.0899)
d_2	-0.0819 (0.0634)	-0.1445 (0.0634)	-0.0043 (0.0512)	0.1348 (0.0893)
σ_i	0.6821 (0.0345)	0.7615 (0.0623)	0.8578 (0.0307)	0.8550 (0.0531)
	Autoregressive Coefficients			
ϕ_1	0.5768 (0.1533)			
ϕ_2	0.3326 (0.1470)			

Note: Estimated standard errors are reported in parentheses.

New York City
Estimation Period: 1965:10 – 2002:12

Parameter	Payroll Employment	Average Weekly Hours in Manufacturing	Unemployment Rate	Real Wages and Salaries
γ_0	0.3081 (0.0396)	0.3931 (0.0863)	-0.1475 (0.0271)	0.0181 (0.0038)
γ_1	----	-0.3907 (0.0867)	----	----
d_1	-0.2280 (0.0656)	-0.4731 (0.0646)	-0.0677 (0.0547)	-0.3108 (0.0882)
d_2	-0.1173 (0.0629)	-0.2965 (0.0561)	-0.0599 (0.0545)	-0.0474 (0.0882)
σ_i	0.7152 (0.0344)	0.7796 (0.0510)	0.9343 (0.0360)	0.8871 (0.0547)
	Autoregressive Coefficients			
ϕ_1	0.4397 (0.1189)			
ϕ_2	0.4848 (0.1161)			

Note: Estimated standard errors are reported in parentheses.

Table 2

Johansen Cointegration Rank Tests

$$\Delta y_t = A_0 + \Pi y_{t-1} + \sum_{i=1}^{2} \Pi_i \Delta y_{t-i} + \varepsilon_t$$

Variable	Hypothesized Number of Cointegrating Equations	Characteristic Root	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
New York State Sales Tax Base	None**	0.154756	51.77403	15.41	20.04
	At most 1	0.009741	2.848393	3.76	6.65
New York City Sales Tax Base	None**	0.119112	41.81502	15.41	20.04
	At most 1*	0.016727	4.908858	3.76	6.65
New York City Withholding Base	None	0.032515	11.70817	15.41	20.04
	At most 1	0.015209	3.708747	3.76	6.65

SOURCE: Critical values are taken from Johansen and Juselius (1990)
** Denotes rejection of the hypothesis at the 1% level
* Denotes rejection of the hypothesis at the 5% level

Variable	Hypothesized Number of Cointegrating Equations	Characteristic Root	Maximum Characteristic Root Statistic	5 Percent Critical Value	1 Percent Critical Value
New York State Sales Tax Base	None**	0.154756	48.92564	14.07	18.63
	At most 1	0.009741	2.848393	3.76	6.65
New York City Sales Tax Base	None**	0.119112	36.90616	14.07	18.63
	At most 1*	0.016727	4.908858	3.76	6.65
New York City Withholding Base	None	0.032515	7.999427	14.07	18.63
	At most 1	0.015209	3.708747	3.76	6.65

SOURCE: Critical values are taken from Johansen and Juselius (1990)
** Denotes rejection of the hypothesis at the 1% level
* Denotes rejection of the hypothesis at the 5% level

Engle-Granger Tests of Cointegration Between
Tax Bases and Indexes of Coincident Economic Indicators

$$Tax\ Base_t = \delta + \rho(CEI_t) + \eta_t$$

$$\hat{\eta}_t = \psi_0 \hat{\eta}_{t-1} + \sum_i \psi_i (\Delta \hat{\eta}_{t-i}) + \upsilon_t$$

Variable	Augmented Dickey-Fuller t-test	10 Percent Critical Value (for T = 500)	5 Percent Critical Value (for T = 500)	1 Percent Critical Value (for T=500)
New York State Sales Tax Base	-7.6152	-3.13	-3.41	-3.96
New York City Sales Tax Base	-3.1985	-3.13	-3.41	-3.96
New York City Withholding Base	-1.4226	-3.13	-3.41	-3.96

SOURCE: Critical values are taken from Fuller (1996, Table 10.A.2)

$H_0 : \psi_0 = 1$

$H_1 : \psi_0 < 1$

Table 3

Vector Error Correction Model for NY State Sales Tax Base and NY State CEI

$$\Delta Tax\ Base_t = \alpha_1 + \gamma_1 (Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{11} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12} (\Delta CEI_{t-i}) + \varepsilon_{1t}$$

$$\Delta CEI_t = \alpha_2 + \gamma_2 (Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{21} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{22} (\Delta CEI_{t-i}) + \varepsilon_{2t}$$

Equation	Right-hand Side Variables					
$\Delta Tax\ Base$	α_1	γ_1	δ	ρ	$\sum_{i=1}^{2} \theta_i^{11}$	$\sum_{i=1}^{2} \theta_i^{12}$
$R^2 = 0.5295$	-0.0019 (0.0076)	-0.6104*** (0.0897)	14.5885	0.7953*** (0.0876)	-0.6403 F=14.65***	2.0849 F=0.71
ΔCEI	α_2	γ_2	δ	ρ	$\sum_{i=1}^{2} \theta_i^{21}$	$\sum_{i=1}^{2} \theta_i^{22}$
$R^2 = 0.8738$	0.0000 (0.0000)	0.0023** (0.0009)	14.5885	0.7953*** (0.0876)	-0.0011 F=1.1022	0.9398 F=951.5***

Note: Estimated standard errors are reported in parentheses.

F-test $H_0 : \theta_1^{ij} = \theta_2^{ij} = 0$

*** Significant at the 1% level

** Significant at the 5% level

* Significant at the 10% level

Table 4

Vector Error Correction Model for NY City Sales Tax Base and NY City CEI

$$\Delta Tax\ Base_t = \alpha_1 + \gamma_1 (Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{11} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12} (\Delta CEI_{t-i}) + \varepsilon_{1t}$$

$$\Delta CEI_t = \alpha_2 + \gamma_2 (Tax\ Base_{t-1} - \delta - \rho CEI_{t-1}) + \sum_i \theta_i^{21} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{22} (\Delta CEI_{t-i}) + \varepsilon_{2t}$$

Equation	Right-hand Side Variables					
$\Delta Tax\ Base$	α_1	γ_1	δ	ρ	$\sum_{i=1}^{2} \theta_i^{11}$	$\sum_{i=1}^{2} \theta_i^{12}$
$R^2 = 0.6107$	-0.0049 (0.0054)	-0.5619*** (0.0905)	14.5049	0.6218*** (0.0531)	-0.8894 F=35.41***	2.8662 F=2.2654*
ΔCEI	α_2	γ_2	δ	ρ	$\sum_{i=1}^{2} \theta_i^{21}$	$\sum_{i=1}^{2} \theta_i^{22}$
$R^2 = 0.9074$	0.0000 (0.0000)	-0.0001 (0.0009)	14.5049	0.6218*** (0.0531)	0.0010 F=0.3145	0.9687 F=1366***

Note: Estimated standard errors are reported in parentheses.

F-test $H_0 : \theta_1^{ij} = \theta_2^{ij} = 0$

*** Significant at the 1% level

** Significant at the 5% level

* Significant at the 10% level

Table 5

Vector Autoregressive Model for NY City Withholding Tax Base and NY City CEI

$$\Delta Tax\ Base_t = \alpha_1 + \sum_i \theta_i^{11} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{12} (\Delta CEI_{t-i}) + \varepsilon_{1t}$$

$$\Delta CEI_t = \alpha_2 + \sum_i \theta_i^{21} (\Delta Tax\ Base_{t-i}) + \sum_i \theta_i^{22} (\Delta CEI_{t-i}) + \varepsilon_{2t}$$

Equation	Right-hand Side Variables		
$\Delta Tax\ Base$	α_1	$\sum_{i=1}^{2} \theta_i^{11}$	$\sum_{i=1}^{2} \theta_i^{12}$
$R^2 = 0.5114$	0.0055 (0.0037)	-1.3938 F=123.082***	1.3871 F=3.5526**
ΔCEI	α_2	$\sum_{i=1}^{2} \theta_i^{21}$	$\sum_{i=1}^{2} \theta_i^{22}$
$R^2 = 0.9210$	0.0000 (0.0000)	0.0006 F=0.2436	0.97442 F=1380.28***

Note: Estimated standard errors are reported in parentheses.

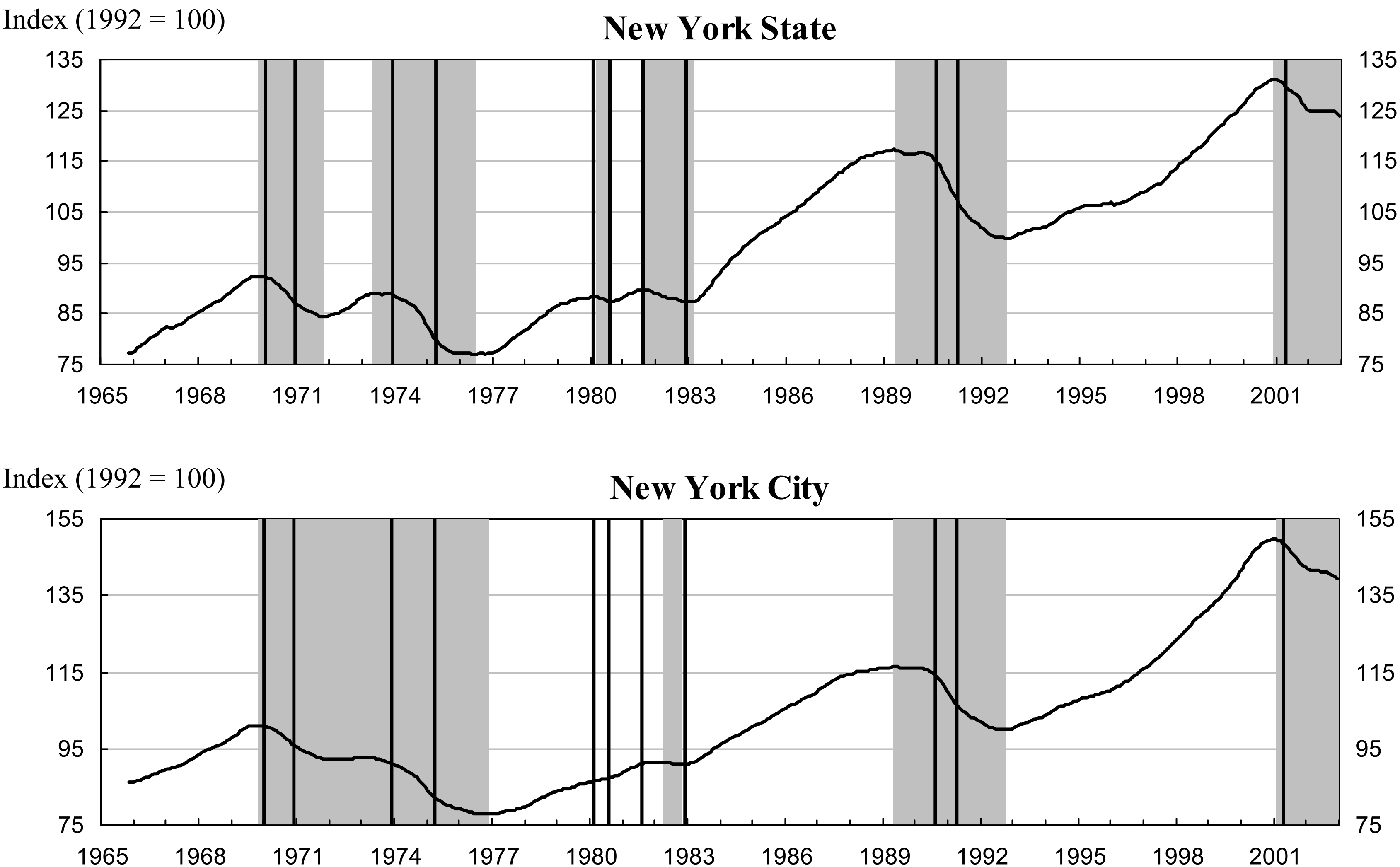
F-test $H_0 : \theta_1^{ij} = \theta_2^{ij} = 0$

*** Significant at the 1% level

** Significant at the 5% level

* Significant at the 10% level

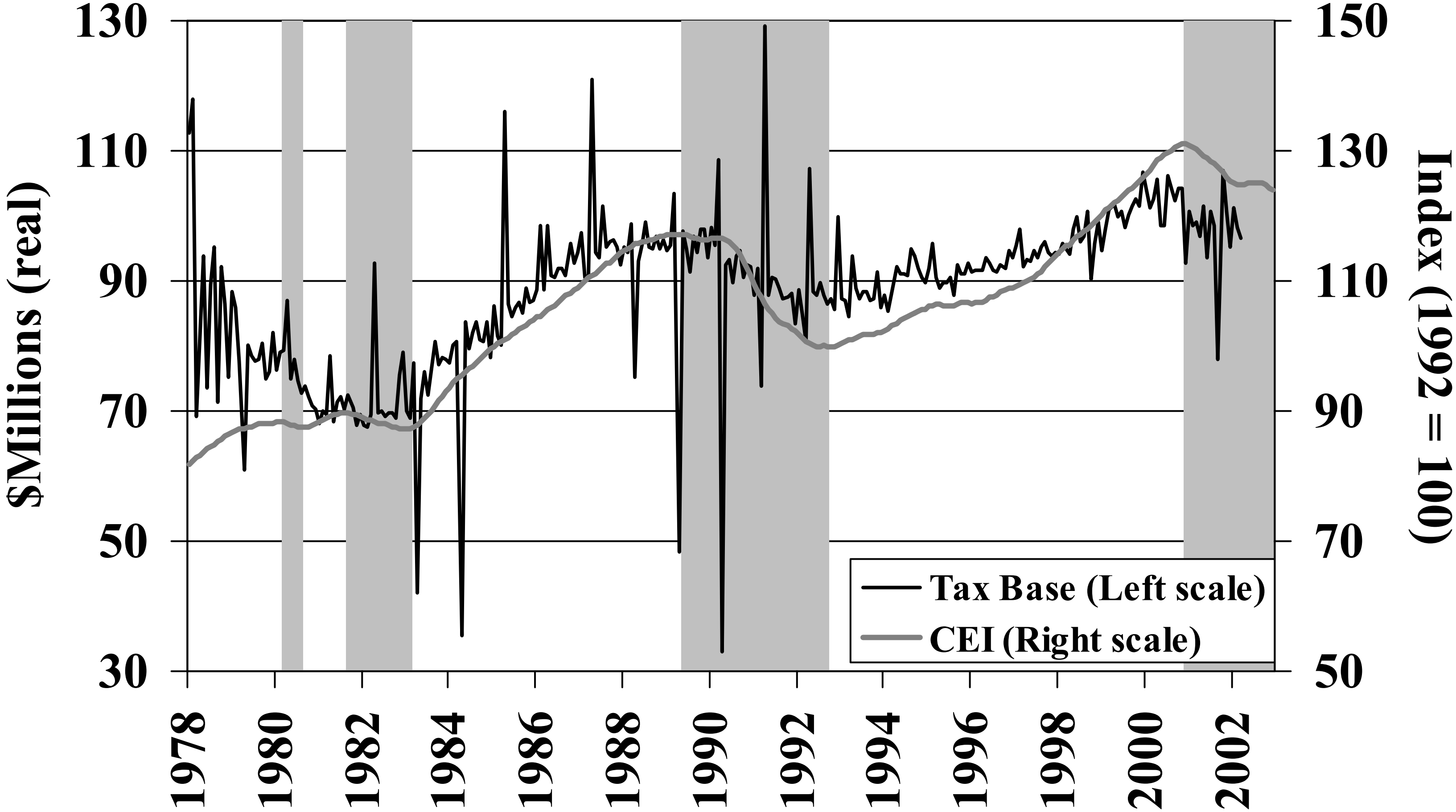
Figure 1: Coincident Economic Indicators



Shading indicates recessions as determined by the CEI.
Vertical lines indicate national peaks and troughs as determined by the NBER.

Figure 2: New York State

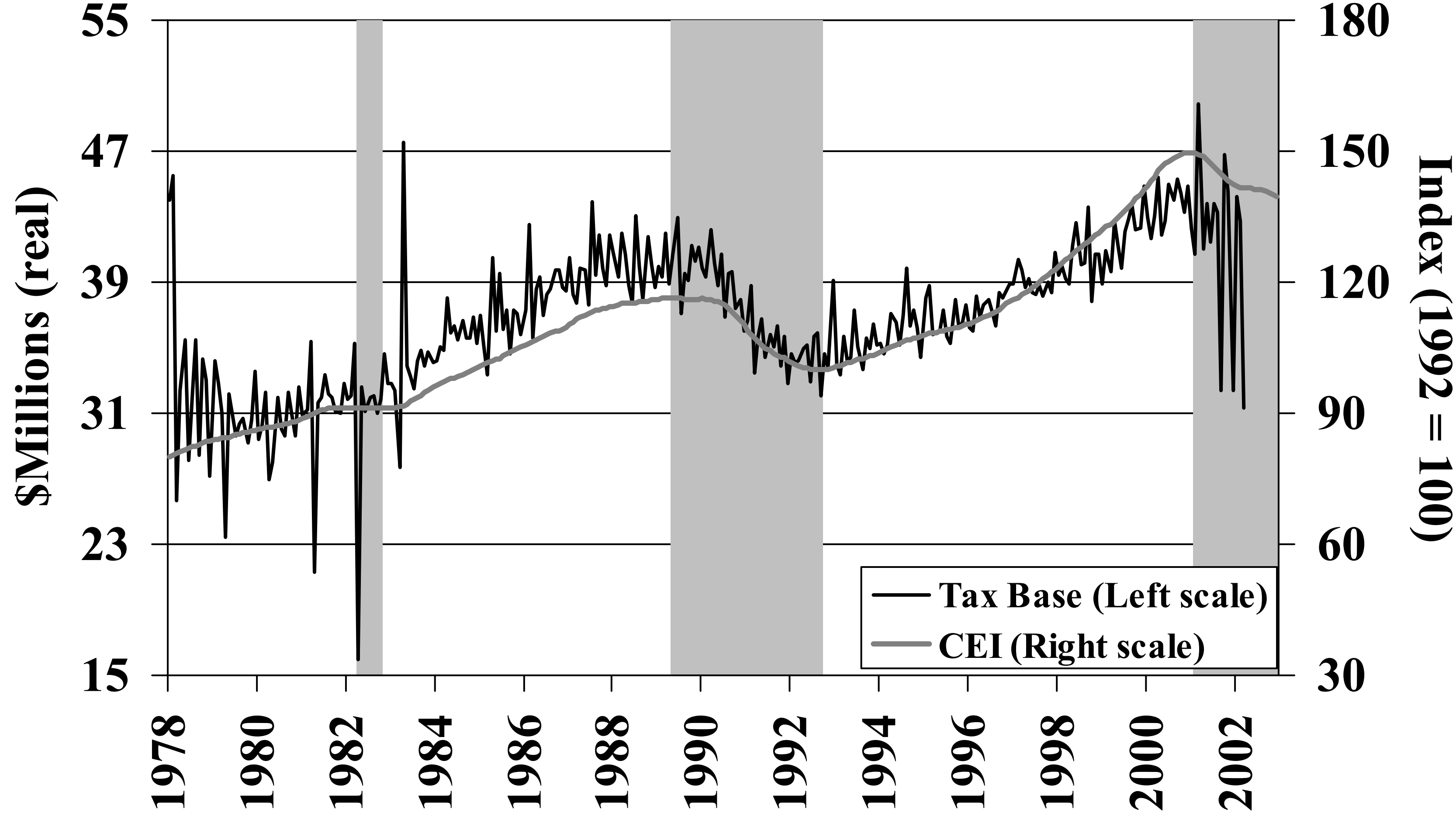
Sales Tax Base and CEI



Shading indicates New York State recessions as determined by the CEI.

Figure 3: New York City

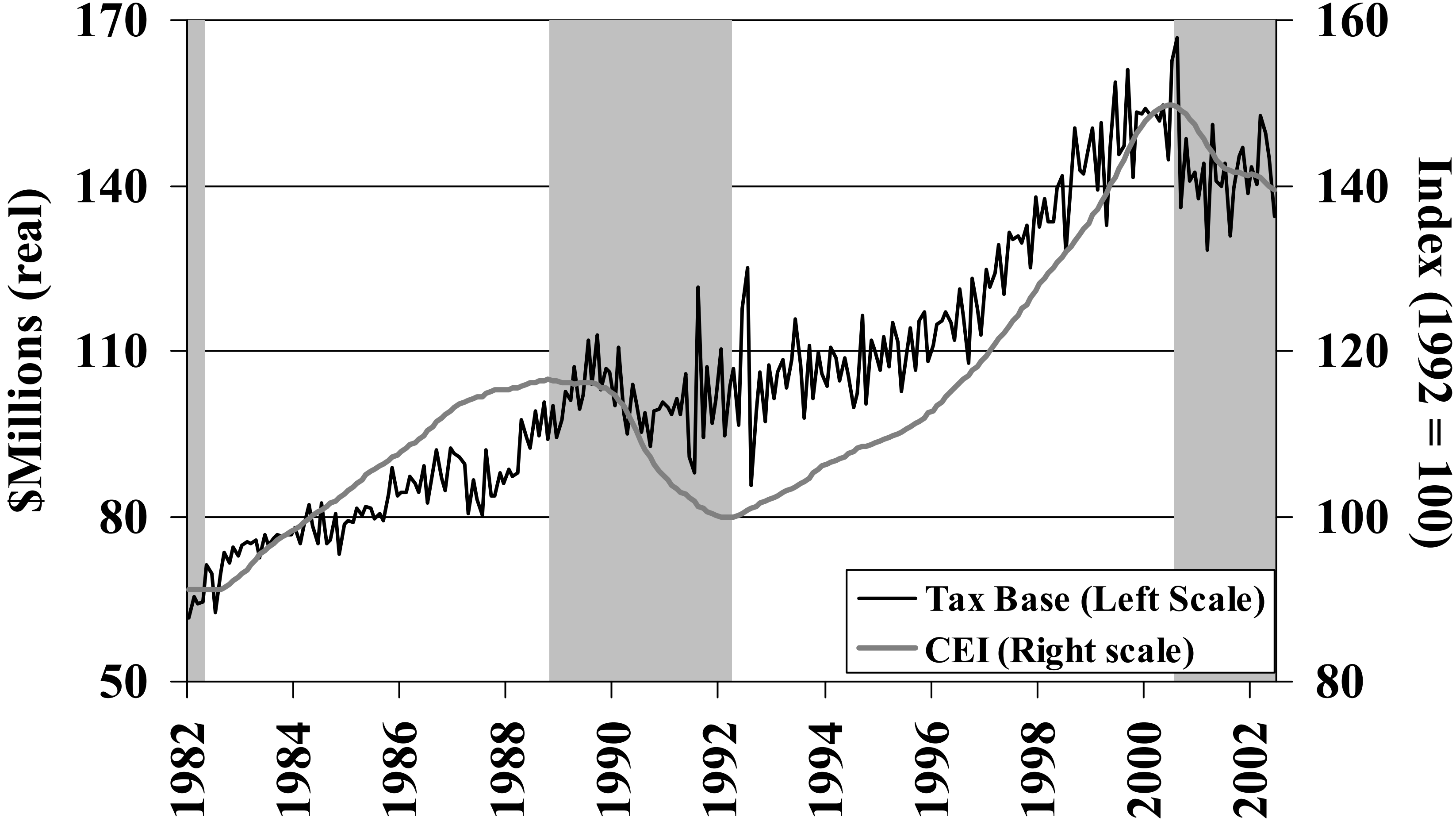
Sales Tax Base and CEI



Shading indicates New York City recessions as determined by the CEI.

Figure 4: New York City

Withholding Base and CEI

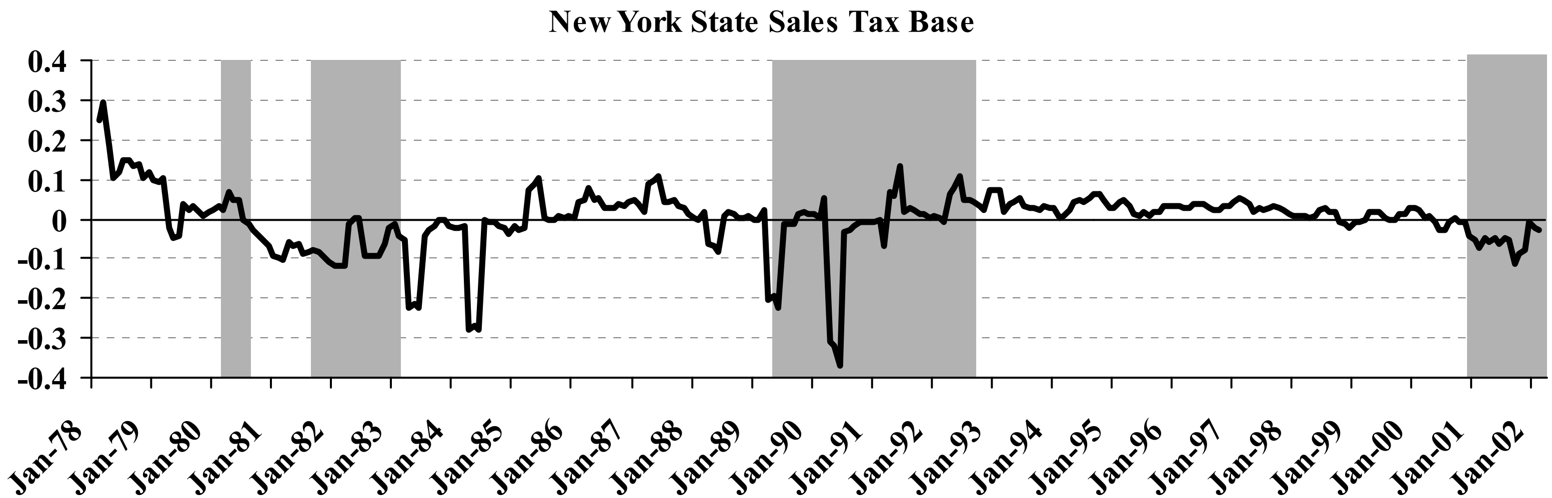


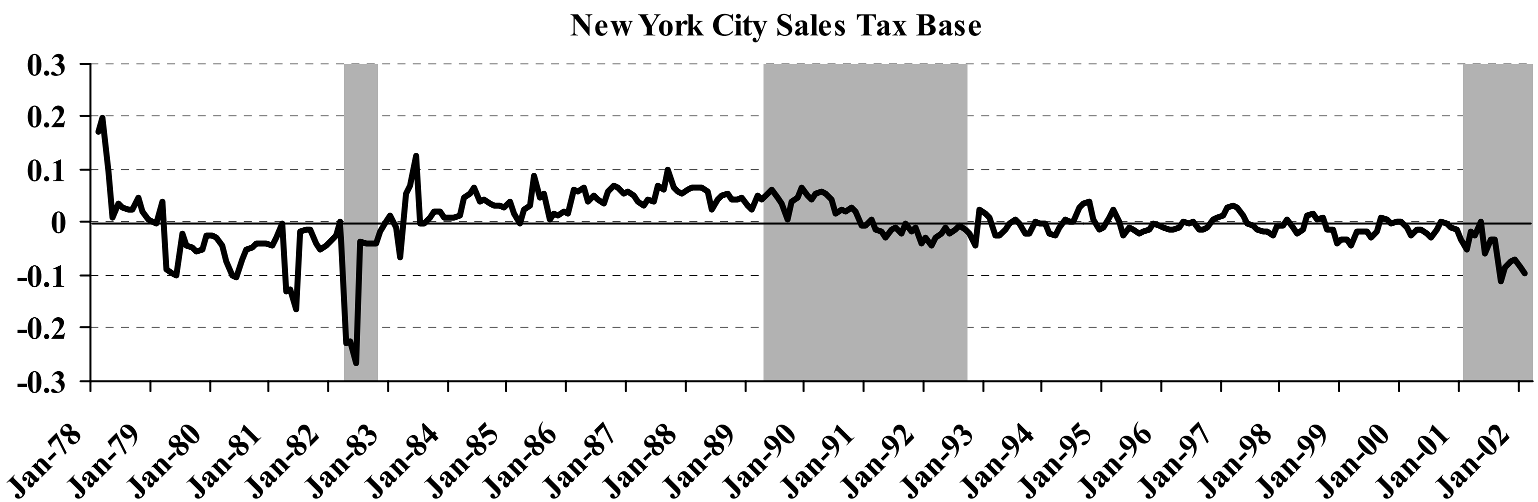
Shading indicates New York City recessions as determined by the CEI.

Figure 5: Estimated Error Correction Terms

New York State and New York City Sales Tax Bases

Centered 3 Month Moving Average





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Appendix: Sales Tax and the Withholding Tax on Personal Income in New York State and New York City[30]

The Sales and Use Tax. Revenues from the New York State sales and use tax (referred to as the sales tax) are derived from many sectors of the economy. The sectoral composition of the New York State and the New York City sales tax bases are broadly similar but New York City derives proportionately less tax from retail trade, 46.9 percent compared to 55. 9 percent for New York State, and proportionately more tax from services, 21.4 percent for New York City compared to 15.8 percent for New York State (Charts 1 and 2). In addition, communications and electric and gas utilities are fractionally more important in the City.

There are significant exemptions to the application of the sales tax. The tax does not apply to most services. For example, professional services, medical services, education services, transportation services are not subject to the sales tax. Purchases for resale and sales to charitable organizations are exempt, as is the sale or rental of real property.[31] Also exempt are sales of machinery, equipment, supplies and tools used directly or predominantly in manufacturing, and sales of fuels and utility services used in manufacturing goods for resale. Areas classified as economic development zones and qualified Empire Zone Enterprises are exempted from the state tax, and localities have an option to offer a similar exemption.

The current statewide sales tax rate is 4.25 percent. Many cities and counties impose an additional tax ranging from 3 to 4.4 percent, bringing the total rate to 7 ¼ to 8.625 percent. In addition, the State also imposes a Metropolitan Commuter Transportation District tax of 0.25 percent in the 12 downstate counties. Nassau County has the state's highest sales tax rate at 8.75 percent while the rate in New York City is fractionally lower at 8.625 percent. An additional 5 percent tax applies to passenger car rentals and information and entertainment services ("900" phone numbers) furnished by telephone and received exclusively aurally. The state collects the local portion of the sales tax and distributes the net collections to the localities.

[30] The tax rates reported in this Appendix reflect the changes to the New York State and New York City tax structures introduced in 2003.
[31] Property transfers are a significant source of tax revenue but are taxed by a different instrument.

New York State's first sales tax, with a top rate of one percent, ended in 1933; the state re-imposed the sales tax in 1965. The same law provided authority for counties and cities to impose a similar tax although some cities (including New York City) and counties had already levied a sales tax. New York City's sales tax dates back to 1934 with a top rate of 2 percent.[32]

Withholding Tax on Personal Income. New York State requires that employers withhold and remit personal income taxes on wages, salaries, bonuses, commissions and similar income within three business days for large businesses, and five business days for certain small businesses, educational and healthcare organizations, following each payroll once the cumulative liability reaches $700. New York State's top tax rate for personal income is 7.70 percent. The rate was as high as 15 percent in the late seventies. Out-of-state residents who work in New York State pay the state tax on that portion of the income earned in New York State. New York City residents pay an additional tax of up to 4.45 percent. The State has administered the New York City personal income since 1976. New York State produces daily collection and refund reports and, at the end of the month, issues a letter stating the final amount of personal income tax revenue by component due to the City for that month.[33]

The withholding portion of the City personal income tax is a function of wages, salaries, and the tax rate. Tax payers may also adjust their witholdings to reflect changes in non-wage income. Among the factors that can cause fluctuations in wages and salaries is the relatively heavy reliance in the finance sector on annual bonus payments. Bonus income is considered a form of wages and salaries subject to withholding. This income is typically a single payment in the final quarter of the year, based largely on employee performance that same year. Some firms, however, pay bonus income in the first quarter of the following year. In a peak year in the financial markets, bonus income can add 1 to 2 percentage points to the growth rate of personal income for the State. While the financial sector is the dominant source of bonus income, other employers including legal firms, manufacturers and many service companies also pay bonuses.

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[32] New York State Tax Sourcebook, NYS Department of Taxation and Finance, Office of Tax Policy Analysis, page 122, 2001 NYS Tax Sourcebook.
[33] Tax Revenue Forecasting Documentation, Fiscal Plan 2002-2006, New York City, Office of Management and Budget, April 3, 2002, page. 22.

Fluctuations in withholdings can be created by intra-year changes in the withholding tax tables, which have occurred periodically in New York State and New York City, and by changes in the prospective federal tax rates for personal income. For example, in 1992 Congress raised the federal tax rates on personal income beginning 1993. As the timing of bonus income payment is largely at the discretion of the firm, bonus income that would have typically been paid in the first quarter of 1993 was accelerated and paid in the fourth quarter of 1992.

Chart 1
Components of New York State Sales Tax Base

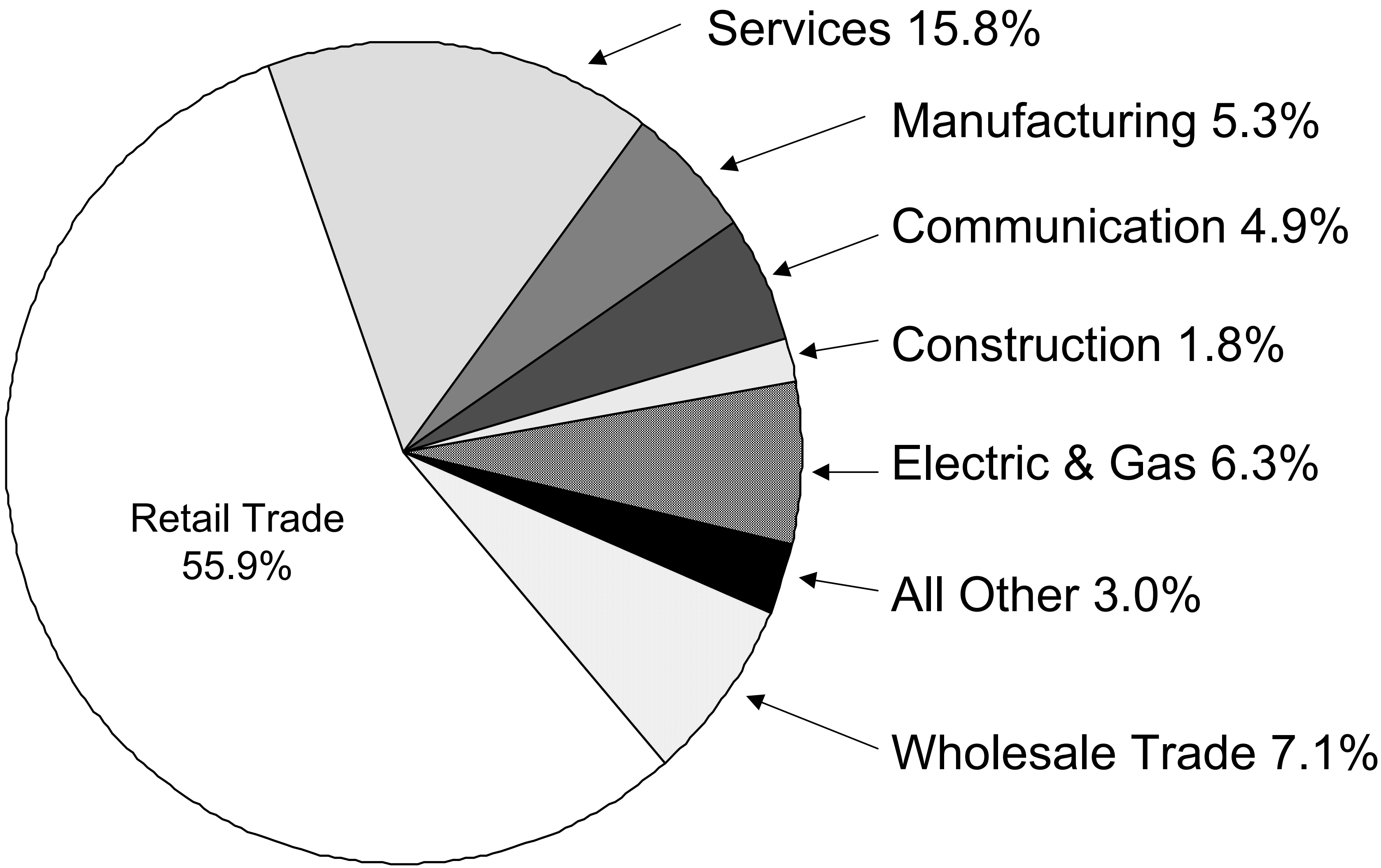

Chart 2
Components of New York City Sales Tax Base