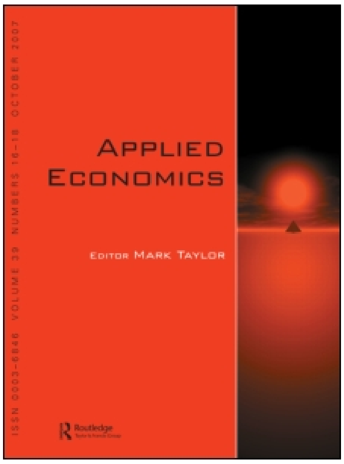

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Is past prologue? Prospects for state and local sales tax bases

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Is past prologue? Prospects for state and local sales tax bases

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General sales taxes provide substantial fractions of state and local revenues in the US. However, state and local sales tax bases have been eroding steadily during the past 50 years. Base erosion contributes to fiscal stress in the states; therefore, prospects for continued sales tax base erosion are important to state tax administrators, policymakers and public finance economists. This article offers a quantitative assessment of base erosion. We construct time series of a representative state sales tax base and its price index, and estimate a structural demand system for 'taxed' and 'untaxed' commodities. We use the estimates to forecast the sales tax base over coming years. Time-series forecasts and a weighted-average forecast are constructed, to reduce the likelihood of forecast error. The results suggest slow, but relentless, base erosion and possible recurring fiscal stress, in states where sales tax revenues make up sizable fractions of total tax revenues.

I. Introduction

Public finance economists have voiced serious concerns about the viability of currently structured state and local general sales and use taxes (Snell, 1993, 2004; Fox, 2003; Mazerov, 2003). First, newly legislated exemptions from the sales tax have eroded the tax base. For example, in the late 1990s North Carolina exempted food for home consumption from the state's general sales tax base. Second, as a result of the US Constitution's Interstate Commerce Clause, a state cannot require remote (i.e. out-of-state) vendors to collect its sales tax, unless the vendor has nexus – that is, physical presence – in the state. States have had meager success enforcing use taxes.[1] Thus, rapid growth in sales by remote internet vendors has contributed to base erosion (Bruce and Fox, 2004). Third, because older consumers spend relatively large fractions of income on untaxed medical commodities, the ageing US population tends to erode sales tax bases.

Finally, and most important from the standpoint of this article, a substantial fraction of sales tax base erosion has resulted from the ongoing shift in the composition of personal spending, away from tangible goods and toward services.[2] For the most part, sales taxes are levied on tangible goods: most services escape sales taxation. Thus, the shift from

[1] In each sales tax state, citizens are required to remit use tax on commodities purchased from remote vendors, if the vendors do not collect the state's sales tax.
[2] For example, the Federation of Tax Administrators (FTA) (1997, p. 1) states 'long-term viability of state and local retail sales taxes continues to be threatened.... One of the primary threats is the increasing proportion of economic activity related to the provision of services as opposed to goods.' Also see Duncombe (1992) and Mazerov (2003).

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tangibles to services tends to reduce the tax base as a proportion of total spending. If past is prologue, state and local policymakers could find themselves on the horns of a 'taxing' dilemma: either tax systems must be reformed, or government services must decline or both. Past shifts in spending are well documented. However, continued sales tax base erosion is not a foregone conclusion. No published empirical analyses forecast future behaviour of general sales tax bases. This article attempts to gauge the immediacy and size of the threat by way of forecasts of sales tax bases.

The evidence adduced here indicates that slow but steady general sales tax base erosion is likely to continue. The unhurried pace of the decline may contribute to the policy problem. Apparent fiscal viability is an illusion, in a way similar to the evident fiscal health of many countries' Social Security programmes. Although not faced with imminent failure, many countries' Social Security systems are structured in a way that renders them unsustainable. The absence of immediate fiscal crisis tends to undermine policymaker's efforts to address the long-term issue. If the forecasts reported below are accurate, US states relying on sales tax revenue eventually could face sustained and substantial fiscal stress. Because general sales taxes provide sizeable fractions of many states' revenue systems, policymakers need to be aware of their true long-run prospects.

Previous papers study the important economic characteristics of sales taxes. The majority of research reported before Dye and McGuire's (1991) contribution focused on revenue functions. Dye and McGuire argue that revenue functions produce imprecise assessments of sustainability because revenue streams often are altered by legislation. These are exogenous changes that make it difficult to separate fundamental economic relationships from legislated changes in tax rates and definitions of tax bases. Dye and McGuire avoid this difficulty by using national data to construct a representative state's sales tax base. With a few exceptions (described in the section 'Some measurement issues and illustrations of sales tax base erosion'), the sales tax base construct we use conforms to Dye and McGuire's 'representative narrow' sales tax base.[3]

Dye and McGuire (1991) report a time-series analysis of past trend growth in tax bases.[4] In contrast, the focus in this article is a model of consumer demand derived from economic theory, and on forecasts of likely future behaviour. Mullins and Wallace (1996) report forecasts of consumption tax bases. They use censored data in a two-stage Tobit model to estimate demographic elasticities. Mullins and Wallace use projections of demographic variables, and estimated elasticities, to forecast the effects demographic trends have on 12 sub-categories of consumption, through year 2000.[5] They use disaggregated Census Bureau data. Demographic changes have important cross-sectional impacts that occur at the household level, so disaggregated data are appropriate in their study. In the work reported here, we study trends in consumer expenditure broadly defined, so we use national [Bureau of Economic Analysis (BEA)] data. In one case, described in footnote 25, we did use individual household data to construct forecasts. However, the results do not differ from those described below, so they are not discussed in detail.

The next section of this article describes the data, describes the structural this model of demand we use to construct initial forecasts and reports on estimation of the model. Section III uses the model to forecast demand for taxed commodities. We also report time-series forecasts, which provide a useful check on forecast accuracy. In Section IV, a weighted-average forecast is incorporated in a Computable General Equilibrium (CGE) model that accounts for behavioural responses to sales taxes. The model helps gauge future fiscal stress that might arise from continued base erosion in sales tax states. This exercise suggests recurring measurable fiscal stress for states that obtain sizable fractions of tax revenues from the sales tax. Section V provides a summary, qualifications and limitations and suggests possible future research.

[3] Dye and McGuire's representative narrow base is personal consumption expenditure minus food for home consumption, most services and motor vehicle fuels. Dye and McGuire carefully note that national consumption data do not account for sales taxes on business inputs. Ring (1999) estimates that on average in the US, 41% of sales tax collections result from tax on sales of business inputs. He points out, however, that states exempting specific commodities from sales taxes on household spending tend to exempt the same commodities from tax on business inputs. Business spending on services is likely to follow a trend similar to personal consumption of services, so this is unlikely to affect the forecasts in a significant way.

[4] They report that the representative sales tax base grew about 2.2%, annually, between 1968 and 1987.

[5] The categories are, food consumed at home, food consumed away from home, apparel services, medical and health spending, entertainment, personal care, household services, apparel, utilities, alcohol, tobacco, gas and oil.

II. Measurement of Base Erosion, and Estimation of a 'Conditional' Almost Ideal Demand System

Some measurement issues and illustrations of sales tax base erosion

State and local general sales taxes are levied primarily on tangible goods: most services are not taxed. This tax structure, together with the secular trend away from goods, is responsible for a substantial fraction of sales tax base erosion. Public finance researchers often use the ratio of goods spending to personal income as a proxy for the sales tax base. However, in this context, the goods/(personal income) ratio has two potentially serious drawbacks: first, if the personal saving rate declines, the ratio of goods spending to personal income can understate sales tax base erosion.[6] Second, because some services are taxed and some goods are not, spending on goods is not the most precise measure of the sales tax base. We make two small – yet important – adjustments to measurement of the sales tax base. First, we normalize spending by personal expenditure, rather than personal income. Second, we define the tax base as 'taxed commodities,' rather than spending on goods.[7]

The first point is that the ratio of tangible goods spending to personal income tends to understate base erosion if the personal saving rate declines.[8] To see this, let the ratio of spending to personal income be $(p \cdot q)/Y = (p \cdot q)/(S + E)$, where q is the quantity of commodities purchased, p is a commodity price index, S is saving, E is total expenditure and $Y \equiv S + E$ is income. If the personal saving rate declines, spending on commodities, in general, increases. In this case, S and E change in opposite directions, but by equal amounts, so the spending/income ratio, $(p \cdot q)/(S + E)$ increases. Assuming the *composition* of spending does not change, and q is the subset of commodities consisting of goods, $(p \cdot q)/(S + E)$ increases.[9] Thus, the spending/income ratio conflates saving-induced changes in spending with composition-induced changes. But only the latter reflects base erosion stemming from the facts that sales taxes are levied, primarily, on tangible goods, and that the secular trend has been away from goods.

As is well known, the US personal saving rate has been declining since the early 1980s. This has tended to increase the ratio of goods to income, understating sales tax base erosion.[10] The measurement error is avoided by normalizing spending by total expenditure, giving $(p \cdot q)/E$. In this case, if saving declines, income is held constant, expenditure increases and the ratio is unaffected. $(p \cdot q)/E$ does not change unless households change the composition of expenditure, so we use this ratio to gauge base erosion. The difference is substantial. The goods/income ratio fell from about 0.58 to about 0.34 between 1947 and 2002, a decline of 24.0 percentage points. The goods/expenditure ratio fell from about 0.69 to about 0.41, in the same period, a decline of 28 percentage points. The goods/expenditure ratio fell 16.7% more than the goods/income ratio. Figure 1 graphs the ratio of goods to total expenditure and the ratio of services to total expenditure.

The second measurement issue is that tangible goods are an imprecise measure of the sales tax base because some goods are not taxed (about 30%) and some services are taxed (about 20%). Thus, a simple demarcation between goods and services does not accurately reflect most states' sales tax bases. Dye and McGuire tailor BEA data to reflect most states' sales taxation of personal expenditure. In a similar way, we replace goods with 'taxed commodities' and services with 'untaxed commodities.' Some services were added to tax rolls after the Dye/McGuire paper was published, so we use Due and Mikesell's (1994) and the Federation of Tax Administrator's (1997, 2004) detailed discussions of states' taxation of expenditures to identify what is taxed and what is not. The following lists include only commodities typically *not* taxed. Using BEA titles, these are:[11]

(1) Goods – opthalmic products and orthopaedic appliances; food purchased for off-premise consumption net of alcoholic beverages for off-premise consumption (which generally are

[6] And it will become clear, below, that the ratio of services spending to income tends to overstate base erosion.
[7] Detailed discussion of taxed commodities follows later.
[8] Liviatan (1961) describes the problem.
[9] The ratio could decline, if the decline in saving causes demand for tangible goods to decline. But there is no reason to believe this would occur, even if saving causes a change in the composition. For example, if the increase in saving causes goods spending to increase, but by less than the increase in services spending, the ratio increases.
[10] This raises an important econometric issue. Generally, measurement error in the left-hand side variable of a regression equation does not cause Ordinary Least Squares (OLS) estimates to be inconsistent. It is standard in demand analysis to use a spending ratio as the left-hand side variable, and total expenditure on the right-hand side. For the reasons just discussed, if saving changes, total expenditure may not be exogenous with respect to the spending/income ratio, and so OLS estimates may be inconsistent.
[11] See the data Appendix for more detail.

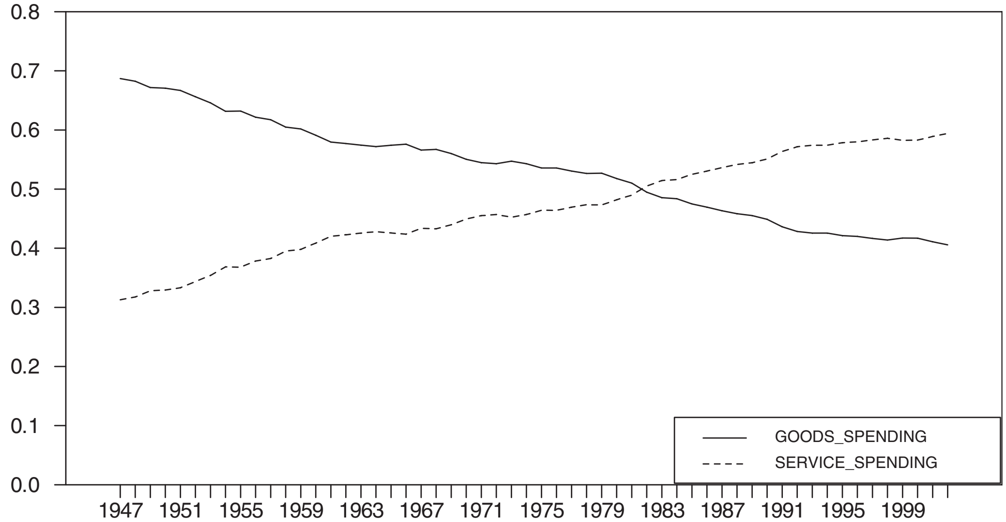

Fig. 1. Personal expenditure on goods and on services (in fractions of total personal expenditure)

taxed); food furnished to employees (including the military) and food produced and consumed on farms; gasoline and oil; drug preparations and sundries; and net foreign remittances (expenditures abroad by US residents net of personal remittances in kind to nonresidents).

(2) Services – housing, net of transient hotels, motels and other traveller accommodations; water and other sanitary services; transportation net of repairs, greasing, washing, parking, storage, rental and leasing; medical care; and other, including personal care, personal business, education and research, religious and welfare activities and net foreign travel (foreign travel by US residents net of expenditures in the US by nonresidents).

The result of this method of tax base accounting appears in Fig. 2. The figure shows that expenditure on taxed commodities fell from about 51.7% of personal expenditure in 1947 to about 39.8% in 2002, a decline of 11.9 percentage points. Recall that expenditure on tangible goods fell about 28.0 percentage points. Thus, using goods, rather than taxed commodities, *overstates* sales tax base erosion by a very large amount.[12] It is useful to keep in mind, therefore, that forecasts based on this approach provide a more conservative picture of sales tax base erosion, than would forecasts based on the goods/expenditure ratio.

Figure 2 indicates the trend in taxed commodities changed in the early 1960s. This change is more apparent in Fig. 3, where separate trends are shown by dashed lines.[13] The fraction spent on taxed commodities declined 6.1 percentage points in the first 15 years of the sample (1947–1961), an average of about 0.41 percentage points per year. Taxed commodities declined 5.8 percentage points in the latter part of the sample (1961–2002), an average of about 0.14 percentage points per year, almost three times slower than in the earlier period. We tested for a break in the time trend. The test rejects the null hypothesis that the two trends are equal in value. The trend after 1961 is much more indicative of recent experience, so we restrict the sample to the period 1961–2002.

The next section of this article describes the estimation of a demand system for taxed and untaxed commodities. Before describing empirical implementation, it is useful to note why we do not measure sales tax bases simply as a ratio of sales tax revenue to the sales tax rate. Demand system estimation requires price indices on the commodities included in the system. Below, we use the individual taxed

[12] Alaska, Delaware, Montana, New Hampshire and Oregon do not levy state sales taxes. The numerator of the taxed commodities ratio includes spending not taxed in these states: the denominator includes spending in all states. Adding a dollar to numerator and denominator increases the ratio, so Fig. 2 overstates the tax base. But population in these five states is only 3% of the US population. Local sales taxes are levied in Alaska, so more than 97% of US residents live in jurisdictions with sales taxes. And there is no *a priori* reason to think spending in these five states has evolved differently than in other states, so measurement error should be small.

[13] The trend lines were constructed by splitting the sample into two parts, 1947–1961 and 1961–2002, and running separate regressions of taxed commodities on constants and linear trends.

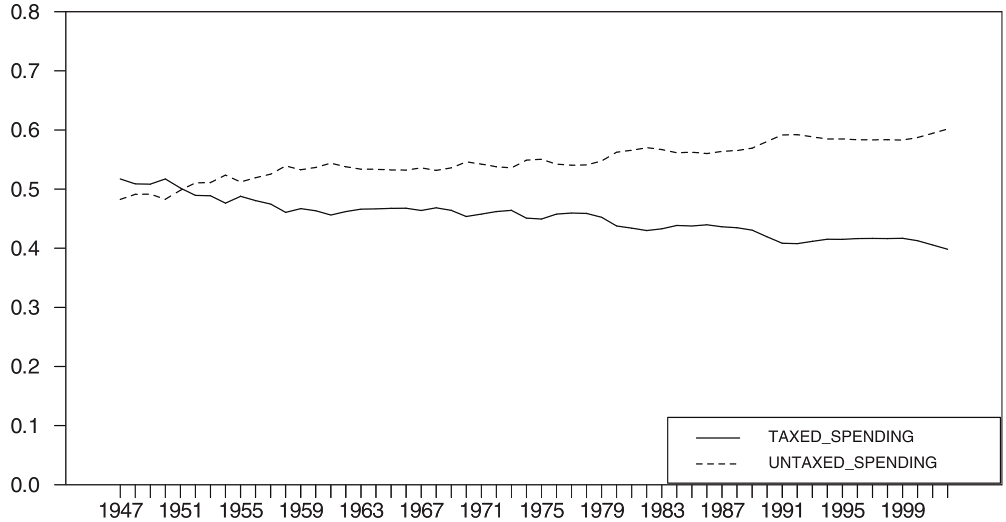

Fig. 2. Personal expenditure on taxed and untaxed commodities (in fractions of total personal expenditure)

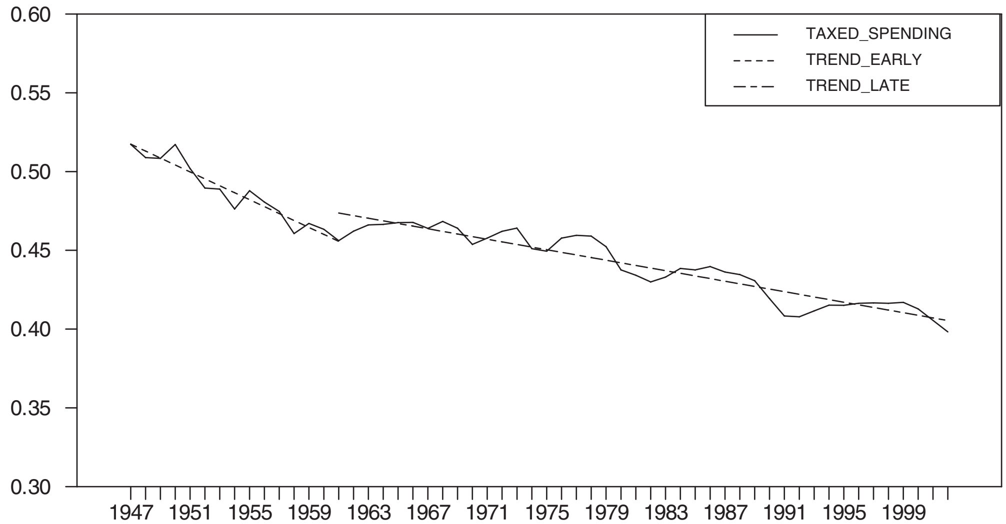

Fig. 3. Pre- and post-1961 trends (taxed commodities as a fraction of total personal expenditure)

commodities, and their corresponding price indices reported by BEA, to construct a price index for the broad category 'taxed commodities.' Likewise, we use the individual untaxed commodities and their prices to construct a price index for the category 'untaxed commodities.' There simply is no way to construct price indices for ratios of taxed and untaxed spending using the revenue/tax rate approach.

Specification of a conditional Almost Ideal Demand System (AIDS) regression model of taxed and untaxed commodities

Deaton and Muellbauer (1980a, b) derive Marshallian demand functions from the minimum expenditure function. Their AIDS is general in that it does not assume demand homogeneity or symmetry, properties that often are rejected by the data. AIDS imposes minimal restrictions, namely that the minimum expenditure function is homogeneous of degree 1 in all prices and is concave in each price. If no additional conditions are imposed, AIDS regresses the fraction spent on each commodity in the demand system on a constant, the natural log of the price of each commodity and logged total personal expenditure.

The original AIDS specification assumes commodity demand and labour market choices are separable. Separability appears unrealistic. For example, the increase in the labour force participation rate of women between the early 1960s and the late 1980s is likely to have increased demand for child care services, food consumed away from home and women's clothing suitable for work. Abbot and Ashenfelter (1976) and Browning and Meghir (1991) test the null hypothesis of separability and find the data reject the null. Thus, excluding labour choice variables from demand system analysis could produce biased and inconsistent estimates. Pollak and Wales' (1992) 'conditional estimation' approach overcomes the missing variables problem. Browning and Meghir (1991) show how to use conditional estimation to model demand systems without needing to solve a full-blown labour supply model. The conditional AIDS model produces unbiased and consistent estimates.

In a framework where each commodity is categorized under the broad types 'taxed' or 'untaxed,' the conditional AIDS specification for taxed and untaxed commodities is

$$w_{i,t} = \alpha_i + \sum_{j=1}^{2} \gamma_{i,j} \ln p_{j,t} + \beta_i \ln\left(\frac{E_t}{P_t}\right) + \varphi_{i,H} \ln H_t + \varphi_{i,LF} \ln LF_t + \varepsilon_{i,t} \qquad (1)$$

The index i is a place-holder for the type of commodity (taxed or untaxed). $w_{i,t}$ is the fraction of personal consumption expenditure on commodity i in year t. Hereafter we refer to $w_{i,t}$ simply as the demand for commodity i. 'ln' signifies the natural log transformation; $p_{1,t}$ is the price index of taxed commodities; $p_{2,t}$ is the price index of untaxed commodities; E_t is nominal total personal expenditure per member of the resident US population; and P_t is a price index. H_t and LF_t, respectively average weekly hours worked and the labour force participation rate, are the conditioning labour supply variables. These two variables often are used to control for labour supply in demand models. $\varepsilon_{i,t}$ is the disturbance term.

Bureau of Economic Analysis (BEA) does not report price indices for taxed or untaxed commodities, so we constructed price indices as weighted-averages of the prices of the individual commodities of each type. We follow the AIDS literature by using Stone's price index for P.[14]

Econometric issues

If variables omitted from Equation 1 are correlated with the regressors and with the fraction of taxed commodities, the regressors are endogenous, and OLS estimates will be biased and inconsistent. We constructed instruments from logs of the current and first lag of the personal saving rate, the percent of population 25 years and older having completed 4 years of high school, the number of children under 5 years of age, the capacity utilization rate, exports of services, exports of goods and the average federal marginal income tax rate.[15] The model is over-identified. We construct the J-statistic to test for instrument exogeneity. First, we estimate Equation 1 by 2SLS. Second, we regress the residuals from the 2SLS regression on a constant and on contemporaneous and lagged values of the instruments.[16] The J-statistic, shown in Column 2 in Table 1, is 9.14, with a p-value of 0.10, indicating the instruments are exogenous.

We used the set of instruments in a Hausman test (1978) for endogeneity of the explanatory regressors in Equation 1. This is a check to see if the coefficient estimates produced by $2SLS$ differs significantly from the estimates produced by OLS. The chi-square test statistic with eight degrees of freedom is 6.17, with a p-value of 0.63. Since this test does not reject exogeneity, the remainder of the discussion focuses on the OLS estimates.

The large p-value for White's (1980) chi-square statistic, Q_{White}, in Table 1 indicates the residuals are homoscedastic. The p-value for the Ljung–Box Q-statistic for autocorrelation in residuals indicates statistically significant serial correlation. Therefore, the SEs shown for the OLS regressions in Table 1 are adjusted using a Newey–West (1987) correction for autocorrelation.

All variables in this analysis exhibit trends. Trending data are nonstationary. Some econometricians recommend transforming data to stationarity before using it in statistical analysis. If the trend is stochastic, differencing the data generally eliminates the trend. If the trend is purely deterministic, the correct approach is to use data in levels and include time trends as additional regressors. The fraction spent on taxed commodities has a purely deterministic trend, while the remaining

[14] Stone's index is $\log P_t = \sum_j w_{j,t} \ln p_{j,t}$. According to Deaton and Muellbauer (1980b), the Stone index is a good approximation if prices are collinear. The correlation between log prices of taxed and untaxed commodities is 0.99.

[15] For the average marginal income tax rate, we extended Stephenson's (1998) time series on the federal individual income tax. See the data Appendix for details.

[16] Stock and Watson (2003) describe the procedure.

Table 1. Estimation of conditional AIDS model of demand for taxed and untaxed commodities

1 Regressor	2 Taxed commodities		3 Untaxed commodities	
Constant	−2.17**	(0.76)	2.17**	(0.76)
Log price of taxed commodities	0.11	(0.08)	−0.11	(0.08)
Log price of untaxed commodities	−0.07	(0.08)	0.07	(0.08)
Log real personal expenditure	0.15**	(0.05)	−0.15**	(0.05)
Log average weekly hours	0.52**	(0.14)	−0.52**	(0.14)
Log labour force participation	−0.01	(0.17)	0.01	(0.17)
Linear trend	−0.01	(0.002)**	0.01	(0.002)**
Quadratic trend	0.00004	(0.00003)	−0.00004	(0.00003)
$\bar{R}^2$	0.95		0.95	
$J(5)_{\text{IVEx}}$	9.14; $p=0.10$		–	
$Q(8)_{\text{Huasman}}$	6.17; $p=0.63$		–	
$Q(35)_{\text{White}}$	38.5; $p=0.32$		–	
$Q(10)_{\text{LB}}$	61.4; $p=0.00$		–	

Notes: The dependent variables in Columns 2 and 3 are the fraction spent on, respectively, taxed and untaxed commodities. J_{IVEx} is the Chi-square statistic for the null hypothesis that Instrumental Variables are exogenous; Q_{Huasman} is the Chi-square statistic for Hausman's (1978) test for exogeneity of regressors named in Column 1; Q_{White} is the Chi-square statistic for White's (1980) test for heteroscedasticity; Q_{LB} is the Ljung–Box Chi-square statistic for the null hypothesis that residuals are not autocorrelated. Numbers in parentheses of below coefficient estimates are SEs. p-values are marginal significance levels.
** indicate statistical significance at 5%.

variables appear to have stochastic trends, making it unclear whether the data should be differenced or used in levels form.[17] We tried both approaches. The levels regressions produce more accurate forecasts, but the differences are small, so trends appear not to present a problem here. Table 1 reports on regressions estimated with levels data, including linear and quadratic trends.[18]

Discussion

The regressions use annual data from 1961 to 2002. The data Appendix describes construction of the tax base and data sources. Columns 2 and 3 in Table 1 show the results of OLS estimation of Equation 1 for taxed and untaxed commodities, respectively. Results of estimating Equation 1 with untaxed commodities on the left-hand side are a mirror image of results with taxed commodities on the left-hand side. We focus on taxed commodities.

Column 2 in Table 1 indicates that an increase in the price of taxed commodities tends to increase the fraction spent on taxed commodities. This occurs because demand for taxed commodities is inelastic with respect to its own price.[19] An increase in the price of untaxed commodities tends to decrease the fraction spent on taxed commodities. This occurs because demand for *untaxed* commodities is inelastic with respect to its own price.[20] An increase in the price of untaxed commodities causes expenditure on untaxed commodities to rise, leaving fewer funds available to purchase taxed commodities. An increase in personal expenditure tends to increase the fraction spent on taxed commodities. This occurs because demand for taxed commodities is elastic with respect to expenditure.[21] The coefficient estimate on average weekly hours is positive and statistically significant. However, average weekly hours fell steadily in the sample (not shown), so the net effect on the fraction of taxed commodities was negative. The coefficient estimate on the labour force variable is small and statistically insignificant. Only one of the two trend regressors is statistically significant. However, a test for the null hypothesis that the two trends are jointly zero produces a p-value of 0.007. To formulate forecasts based on levels data, we include both trends in the forecast model. In cases where the data are differenced, the trends are excluded.

[17] We used Augmented Dickey–Fuller tests to check for stochastic trends. Results are available on request.
[18] The estimation results using differenced data are available on request.
[19] The uncompensated own-price elasticity of demand for taxed commodities is −0.73. Table 1 reports estimates of the ordinary, Marshallian, demand curves. These are appropriate for forecasting. Hicksian, compensated, demands, would be appropriate in a welfare analysis.
[20] The uncompensated own-price elasticity of demand for untaxed commodities is −0.88.
[21] The income elasticity of demand for taxed commodities is 1.39.

III. Forecasts

This section forecasts demand for taxed commodities. Our ultimate goal is to forecast beyond the end of our sample (2002). First, however, we truncate the sample in 1992, and forecast taxed spending from 1993 to 2002. This allows us to generate Root Mean Square Forecast Errors (RMSE) as a check on forecast accuracy, and to formulate weights for use in weighted-average forecasts beyond 2002.

Forecasts, 1993–2002

We construct a series of one-step-ahead forecasts from 1993 to 2002 in the following way: first we estimate the AIDS model using actual observations from 1961 to 1992, and construct a one-step-ahead forecast of taxed commodities for 1993. Then we re-estimate the model using actual observations from 1961 to 1993, and construct the one-step forecast for 1994. Continuing iteratively we generate one-step forecasts out to 2002. Figure 4 shows actual values and the forecasts when levels data are used. RMSE for this forecast is 0.009. Figure 5 shows forecasts when the data are measured in first differences. RMSE for this forecast is 0.014.

Structural models impose discipline on analysis by restricting relationships among economic variables. Theoretical restrictions sometimes are not true to the underlying data generating mechanism. In this case,

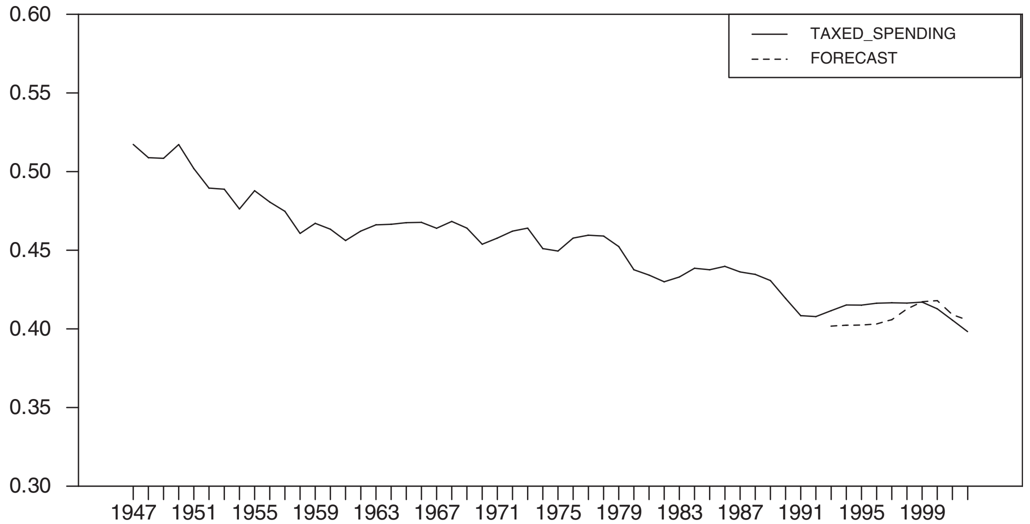

Fig. 4. In-sample forecast from AIDS model (levels data)

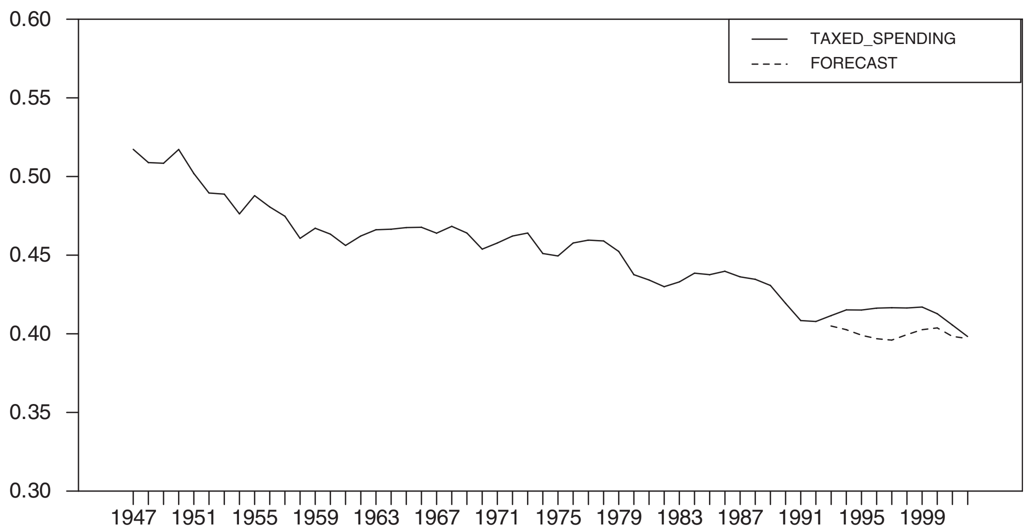

Fig. 5. In-sample forecast from AIDS model (first-differenced data)

the model could be mis-specified, and produce large forecast errors. Pure time-series models provide an alternative that can be useful as a check on structural forecast accuracy. We used standard techniques (on differenced data) to identify an Autoregressive Integrated Moving Average [ARIMA(0,1,1)] model for taxed commodities. RMSE for the forecast is 0.003.[22] The AIDS model includes six economic variables. Vector Autoregressive (VAR) models provide a natural alternative for multi-variate time-series forecasts. We estimate a VAR with the data in levels, including linear and quadratic trends.[23] RMSE for the forecast is 0.005. Estimating the VAR in differences gives RMSE of 0.016.

Forecasts, 2003–2017

This section reports forecasts beyond the end of our sample in 2002. We first generate time-series forecasts of the regressors in Equation 1. We estimated separate 'rolling' ARIMA models for each regressor, and generated one-step forecasts for each year from 2003 to 2017. Taking personal expenditure as an example, in the first iteration we use data from 1961 to 2002 to estimate an ARIMA model for personal expenditure, and then use the estimated ARIMA model to produce a one-step forecast of personal expenditure for 2003. In the second iteration, the data point for 1961 is dropped, and the previously constructed forecast for 2003 is added, creating a revised sample covering the period 1962 to 2003. The ARIMA model is re-estimated based on this sample, and used to produce a one-step forecast for 2004. This continues until we have one-step forecasts extending to 2017 for each regressor.[24]

Next we construct a set of rolling one-step forecasts of demand for taxed commodities. In the first iteration, we use the 1961–2002 sample to estimate the AIDS model by regressing taxed commodities on a constant and the regressors. The resulting coefficient estimates, together with the predicted regressors for 2003, then produce a one-step forecast of taxed commodities in 2003. In the next iteration, we drop the data point for 1961, add the forecasted value for 2003 to the sample, and re-estimate the model.

Figure 6 graphs forecasts produced by the AIDS model (data in levels, including trends). The actual fraction spent on taxed commodities in 2002 was 0.398. The model predicts the fraction spent on taxed commodities would be 0.400 in 2003, and would decline to 0.353 in 2017. Figure 7 graphs forecasts produced by the AIDS model with differenced data. Here the prediction is 0.334 in 2017. The ARIMA(0,1,1) model of the sales tax base predicts a value of 0.369. The VARs with levels and differenced data predict values of 0.357 and 0.350, respectively. The 2017 forecasts range from a high of 0.369 for the ARIMA model to 0.334 for the differenced AIDS model.[25]

Diversified portfolios of forecasts can be used to reduce the risk of forecast error (Granger and Newbold, 1986, Ch. 9; Diebold and Lopez, 1996; Marcellino, 2002). Marcellino describes how to average forecasts using weights constructed from the reciprocals of RMSEs. Larger RMSEs indicate greater uncertainty. Using Marcellino's approach, the less certain is a forecast, the larger is the forecast's RMSE, and the smaller the weight on that forecast. ARIMA predicts the smallest decline in the sales tax base, and has the smallest RMSE, so it gets the most weight. The differenced models predict the largest declines in the tax base, but have the largest RMSEs, so they get the least weight. Thus, Marcellino's weighting scheme produces a conservative measure of the decline in the sales tax base. This approach produces a weighted-average forecast in 2017 equal to 0.359. The weighted-average forecast is labelled WEIGHT_AV_FORCST in Fig. 8. The figure also shows the simple average of the five forecasts, SIMPLE_AV_FORCST, which is 2017 in 0.353.

[22] Graphs for the time-series forecasts are not shown, and are available on request.

[23] The order in which variables enter VARs affect results. The rule is to place last the variable that is most likely to be affected by other variables in the model. The order we used is: (1) personal expenditure, (2) price of taxed commodities, (3) price of untaxed commodities, (4) average weekly hours, (5) labour force participation rate, (6) fraction spent on taxed commodities. Sims' (1980) chi-square test suggests including two lagged values of each variable.

[24] Evolution of economic relationships provides the rationale for dropping the oldest data points. As relationships evolve, the oldest data become less representative of current reality.

[25] Recall this forecast is constructed from aggregate annual National Income and Product Account data, 1961–2002, produced by the BEA. Because policymakers are concerned about the way individual households in their jurisdictions are affected, the referee suggests using individual household data. We collected Consumer Expenditure Survey (CES) data reported by the Inter-University Consortium for Political and Social Research, and constructed a dataset for taxed and untaxed commodities purchased by individual households. There are some difficulties matching categories of taxed and untaxed commodities in the two datasets. Also the CES data begins in 1984, but is quarterly, in comparison with our aggregate annual sample, which extends back to 1961. Nevertheless, the individual household data generates forecasts that are very close to the ones reported here: in this case, the forecast for 2003 is 0.410 and declines to 0.337 in 2017.

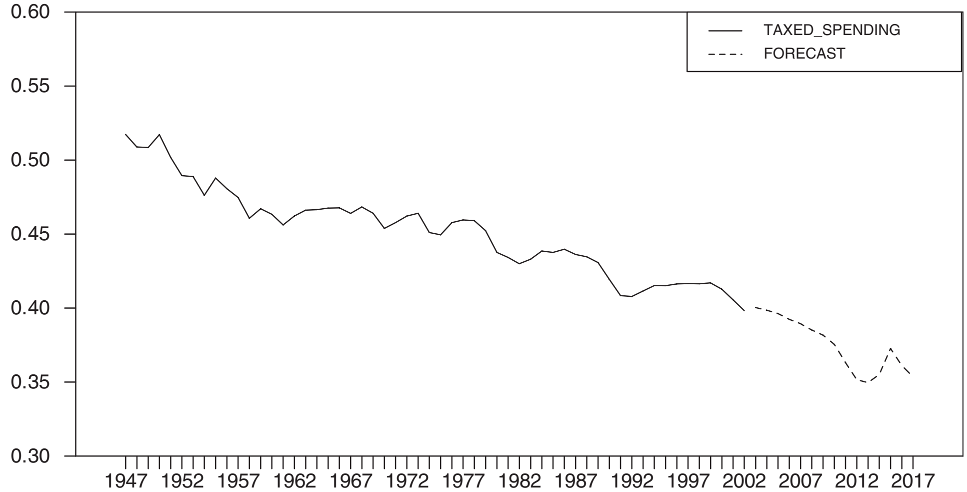

Fig. 6. Out-of-sample forecast from AIDS model (levels data)

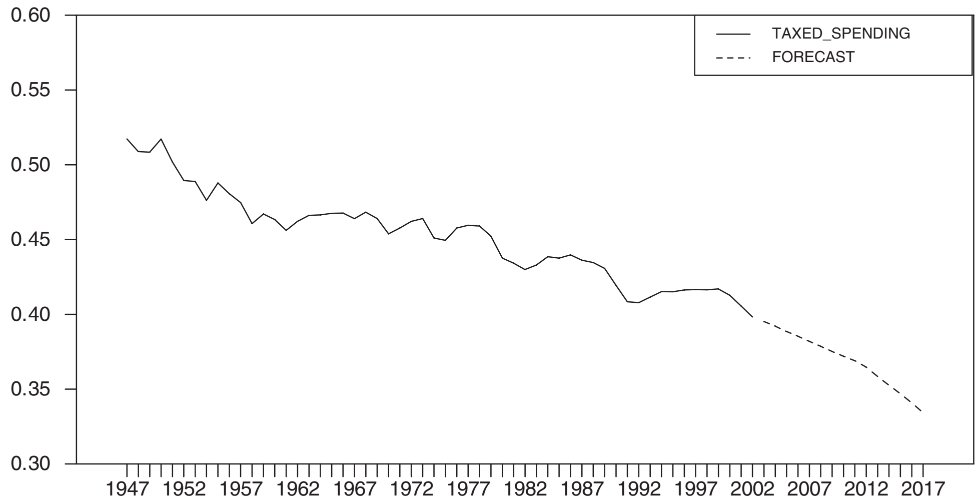

Fig. 7. Out-of-sample forecast from AIDS model (first-differenced data)

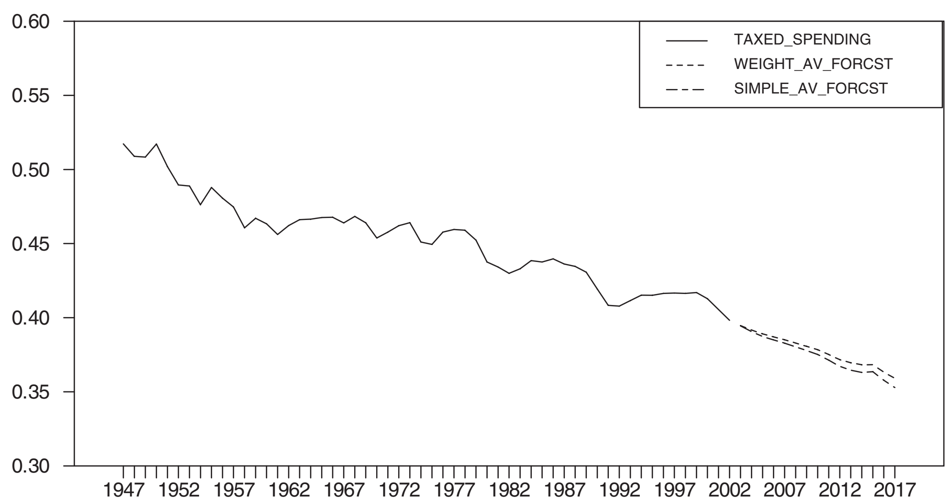

Fig. 8. Averaged forecasts

Notes: 'WEIGHT_AV_FORCST' is the weighted-average forecast with weights calculated from reciprocals of RMSEs, as described in the text. 'SIMPLE_AV_FORCST' is calculated by simple averaging of five forecasts.

The demand for taxed commodities was 0.398 in 2002. The weighted average forecast suggests the demand for taxed commodities would be 0.359 in 2017, a decline of 0.26 percentage points per year. Between 1961 and 2002 demand for taxed commodities fell 0.14 percentage points per year. This suggests the negative trend in sales tax bases could be accelerating.

IV. What Might Lie Ahead for States Relying on Sales Taxes?

Why might sales tax base erosion occur in the first place, and what are the implications?

It is interesting to note the possibility that the relative decline in taxed commodities we document could result from structural features of the economy. If so, the trend is unlikely to abate on its own. Baumol (1967) and Baumol *et al.* (1985) argue that productivity growth in production of manufactures has a structural tendency to exceed productivity growth in production of services. Thus, the relative price of tangible goods tends to decline. If demand for goods and demand for services both are inelastic with respect to their own prices, spending on tangible goods will tend to decline relative to services.[26] Baumol's argument may apply here, because tangible goods make up the lion's share of taxed commodities. In this case, we should expect the price of tangible goods to trend down in relative terms. The relative price of taxed commodities fell about 43% between 1947 and 2002 and we found the demand for taxed and untaxed commodities are inelastic with respect to their own prices. Thus, base erosion may persist, as a structural feature of the economy.

What might lie ahead?

What do the forecasts suggest for the typical sales tax state's budget? In the attempt to quantify the adjustments that would be required, we incorporate the weighted average forecast in the CGE model developed by Russo (2005). That model suggests that if policymakers in the typical sales tax state take no other action, by 2017 the state plus local sales tax rate would have to increase about one percentage point from its current median value of about 7%, in order to maintain revenue as a fraction of total (state plus local) expenditure. Alternatively, if no action is taken, total sales and income tax revenue in a typical sales tax state would decline about 6.4% by 2017. Actual effects would not be evenly spread among states, with dislocations being higher in states relying most on sales taxes on tangible goods, such as Florida, Texas and Washington, and less in states relying more on income and property taxes, such as New York and North Carolina. The adverse affects would be less severe in at least two sales tax states, namely, Hawaii and New Mexico. Both states tax services very broadly, insulating their sales tax bases from the secular trend in services.

Wherever possible, we have erred on the side of caution, and chosen relatively conservative approaches to measurement. A number of additional considerations suggest our forecasts are likely to *understate* the extent and fiscal impact of sales tax base erosion. First, we have focused on personal expenditure. Excluding business inputs causes our base measure to understate the extent of past base erosion, so the forecasts tend to underpredict future base erosion. Second, the ongoing positive trend in expenditure on untaxed medical services is likely to accelerate after baby-boomers retire, since retirees tend to spend disproportionately in this category. Third, food consumed at home declined from 19.8% of personal expenditure in 1947 to 7.3% in 2002, as Americans substituted taxed restaurant meals for (usually) untaxed home-cooking. This has dampened base erosion. But food consumed at home cannot fall much further, so the damping effect must eventually dissipate.

Fourth, as is well known, the Interstate Commerce Clause and Supreme Court rulings prevent states from requiring remote vendors to collect their sales and use taxes. Thus, a sizable fraction of internet sales are untaxed. Goolsbee (2000a) estimates relatively large tax elasticities for internet sales, suggesting that households use the internet to avoid tax on otherwise taxable commodities. In a second paper Goolsbee (2000b) provides evidence that internet sales tax sensitivity increases over time. Goolsbee (2001) and Bruce and Fox (2004) report sizable estimates of foregone sales tax revenue from internet sales and Forrester Research (2004) predicts online sales growth of 14%, compounded annually, between 2004 and 2010. Because our data do not

[26] Baumol argues that labour input is an indicator of quality in many services, making it difficult to reduce the amount of labour used to produce them. In contrast, quality in most manufactured products does not depend on the amount of labour input: consumers do not measure the quality of refrigerators on the basis of the amount of labour hours it takes to produce them. Thus, it is relatively easy to increase labour productivity in tangible goods, and so the relative price of tangible goods tends to decline. Note that Bosworth and Triplett (2003) offer a counter-argument.

reflect the positive trend in internet sales of taxed commodities, it tends to understate sales tax base erosion.

V. Conclusion

For more than five decades state and local sales and use of tax bases have declined as fractions of household expenditure. Public finance economists have expressed doubts about the future reliability of currently structured sales taxes. This article attempts to quantify the long-term prospects for sales tax bases. We construct a representative state sales tax base, as well as a price index for the tax base. Then we estimate a demand system for taxed commodities, and use the estimates to forecast sales tax bases. We use the conditional AIDS model to estimate the demand for taxed commodities, and to generate forecasts. As a check on the predictions, we also estimate pure time-series models. We combined the results in a weighted-average out-of-sample forecast for demand for taxed commodities.

The results are subject to a number of qualifications. First, in general, a forecast is, essentially, an extrapolation of a trend. There always is a probability the trend will change course, causing reality to diverge from the forecast. Second, this article constructs a measure of a sales tax base that includes what a 'typical' sales tax state includes in its sales tax base. This does not represent the sales tax base in any particular state. The representative base approach is useful because time-series data on prices of taxed and untaxed commodities are not available, and the prices are necessary to estimate a demand system. The representative tax base approach is useful because it allows researchers to exploit the data that are available.

The forecasts we report indicate persistent declines in sales tax bases in the future. But forecasts are created merely by looking backward, and then extrapolating past trends. Baumol (1967) and Baumol *et al*. (1985) explain structural features of the economy suggesting the decline in relative spending on taxed commodities is likely to persist, because of a natural tendency for manufacturing productivity growth to exceed services productivity growth. If so, and sales tax bases are not reformed, government services must decline (in proportion to income) or tax rates must rise in the typical sales tax state. To gauge the possible fiscal effects we incorporate the weighted-average forecast in a computer simulation model. To sustain the current ratio of revenue to income in a typical sales tax state, the model predicts that by 2017 the sales tax rate would have to increase by more than a full percentage point, from the current median value of 7%. Alternatively, state and local sales-plus-income tax revenue would fall about 6.4%. Finally, our predictions may be too optimistic because they do not reflect demographic, institutional and economic transformations looming on the economic horizon.

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Appendix: Data Used and Sources

We measure a representative state's sales tax base by specifying particular types of expenditure taxed in most states. We categorize taxed and untaxed expenditure according to Due and Mikesell (1994) and the FTA. Tangible goods generally not taxed include:

(a) ophthalmic products and orthopaedic appliances;
(b) food purchased for off-premise consumption net of alcoholic beverages for off-premise consumption;
(c) food furnished to employees, military and produced and consumed on farms;
(d) gasoline and oil;
(e) drug preparations and sundries;
(f) net foreign remittances (expenditures abroad by US residents net of personal remittances in kind to nonresidents).

Using line numbers from BEA Table 2.4.5, goods not taxed is calculated by

$$\text{Line } 1 - [(\text{Line } 23 - \text{Line } 27) + \text{Line } 25 + \text{Line } 34 + \text{Line } 41 + \text{Line } 44]$$

Services generally not taxed include:

(a) housing net of transient hotels, motels and other traveller accommodations;
(b) water and other sanitary services;

(c) transportation net of repairs, greasing, washing, parking, storage, rental and leasing;
(d) medical care;
(e) other, including personal care, personal business, education and research, religious and welfare activities, and net foreign travel (foreign travel by US residents net of expenditures in the US by nonresidents).

Using line numbers from BEA Table 2.4.5, services not taxed is calculated by

$$\text{Line } 47 - [(\text{Line } 48 - \text{Line } 52) + \text{Line } 56 + (\text{Line } 60 - \text{Line } 62) + \text{Line } 72 + \text{Line } 81]$$

A. Personal consumption expenditures, by type of product: from BEA Table 2.4.5

http://www.bea.doc.gov/bea/dn/nipaweb/TableView.asp?SelectedTable=69&FirstYear=2002&LastYear=2003&Freq=Year
Line 1, Personal consumption expenditures
Line 2, Durable goods
Line 17, Ophthalmic products and orthopaedic appliances
Line 21, Nondurable goods
Line 23, Food purchased for off-premise consumption
Line 25, Food furnished to employees, military and food produced and consumed on farms
Line 27, Alcoholic beverages for off-premise consumption
Line 34, Gasoline and oil
Line 41, Drug preparations and sundries
Line 44, Net foreign remittances
Line 47, Services
Line 48, Housing
Line 52, Other (including transient lodging)
Line 56, Water and other sanitary services
Line 60, Transportation
Line 62, Repairs rental and leasing etc. of vehicles
Line 72, Medical care
Line 81, Other (including personal care and business, education, religious and net foreign travel).

B. Price indices, personal consumption expenditures, by type of product: from BEA Table 2.4.4

http://www.bea.doc.gov/bea/dn/nipaweb/TableView.asp?SelectedTable=68&FirstYear=2002&LastYear=2003&Freq=Year
Line 1, Personal consumption expenditures
Line 2, Durable goods
Line 17, Ophthalmic products and orthopaedic appliances
Line 21, Nondurable goods
Line 23, Food purchased for off-premise consumption
Line 25, Food furnished to employees, military and food produced and consumed on farms
Line 27, Alcoholic beverages for off-premise consumption
Line 34, Gasoline and oil
Line 41, Drug preparations and sundries
Line 44, Net foreign remittances
Line 47, Services
Line 48, Housing
Line 52, Other (includes transient lodging)
Line 56, Water and other sanitary services
Line 60, Transportation
Line 62, Repairs, rental, and leasing etc. of vehicles
Line 72, Medical care
Line 81, Other (including personal care & business, education, religious and net foreign travel).

C. Bureau of Labor Statistics: http://www.bls.gov/

Labour force participation rate, civilian, 16 years up.

D. Census Bureau: http://www.census.gov/index.html

Children under 5 years, series No.HS-3, Population by age 1900–2002.Resident population, mini historical series, No HS-1.

E. Miscellaneous

Personal saving as percentage of disposable personal income, BEA, Table 5.1 and Table 2.1.
Domestic workers engaged in production, domestic industries, BEA, Tables 6.8 A, B, C and D.
Hours, full and part-time employment, domestic industries, BEA, Tables 6.9 B, C and D.
Average marginal effective personal income tax rate, 1947–1995, Stephenson (1998), Table 1. 1996–2002, author calculations.
Population 25 years and older having completed 4 years of high school, Statistical Abstract of the US.