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An Efficiency Analysis of Proposed State and Local Sales Tax Reforms

Benjamin Russo*

With few exceptions, state and local general sales and use taxes are levied primarily on tangible goods. Secular trends in production and consumption of goods and services, as well as legislated exemptions and exclusions, have eroded sales tax bases. A number of reforms designed to reduce base erosion have been proposed, including base broadening, conversion to a consumption tax, and wholesale replacement of sales taxes with income taxes. Each proposal has potential to shore up sales tax bases. From an economic perspective, the policy choice should turn on efficiency, equity, and simplicity. This paper reports on a computer analysis of efficiency effects. The results suggest that (i) base broadening can increase economic efficiency, (ii) converting to a consumption tax base dominates base broadening, (iii) replacing sales taxes with higher income taxes could produce large efficiency losses, (iv) base broadening could generate efficiency gains even if untaxed remote sales become a “sizable” fraction of total sales, and (v) even partial base broadening could produce sizable efficiency improvements.

JEL Classification: H2

1. Introduction

State and local tax policymakers face a large number of particularly severe public finance conundrums.¹ One pressing long-run issue is the slow but steady erosion of state and local general sales and use tax bases.² With a few well-known exceptions, sales taxes are levied primarily on tangible goods.³ Most services are untaxed, and services have grown as a share of consumption spending.⁴

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¹ Many knotty public finance issues are more acute at the subnational level than at the national level: Some are completely absent at the national level. Examples are difficulties collecting use taxes; taxation of professional services, such as advertising; determination of nexus; and tax competition. These important issues are not discussed here since this paper focuses on efficiency effects of proposals to reduce structural tax base erosion. See Snell (1993) and the papers in Brunori (1998), McLure (2000, 2001), and Tannenwald (2001) for discussion of other issues. Hellerstein (1988) provides a trenchant, enlightening discussion of Florida’s attempt to tax advertising.

² To ease exposition, “state and local general sales and use tax” is replaced by “sales tax” wherever clarity permits.

³ The most prominent exception is food purchased for home consumption (Due and Mikesell 1994; Fox 2003). Federation of Tax Administrators (2004) data indicate that 29 states and the District of Columbia exempt food for home consumption. However, in three of these states, local sales taxes tax this category of food. Food for home consumption (net of alcoholic beverages, which generally are taxed) declined from 19.8% of personal consumption spending in 1947 to 7.3% in 2002. Since there is an obvious lower bound on this fraction, food may become less of a factor.

⁴ Using Due and Mikesell’s (1994) and the Federation of Tax Administrators’ (1997) enumerations of taxed and untaxed commodities, in 2002 sales taxes were levied on about 68% of personal consumption spending on tangibles and 20% of personal consumption spending on services.
Thus, sales tax bases have declined as shares of total spending.\textsuperscript{5} At the same time, legislators have increased tax rates.\textsuperscript{6} Since consumers tend to substitute away from products whose relative prices have risen, higher tax rates tend to exacerbate the problem they are intended to address.

A number of reforms designed to reduce base erosion have been proposed. These include broadening tax bases, transforming sales taxes to a consumption base, and wholesale replacement of sales taxes with income taxes. Each proposal has some potential to shore up sales tax bases; thus, from an economic perspective, the policy choice should turn on efficiency, equity, and simplicity effects. Very little quantitative information on the efficiency effects of such proposals is available. This paper uses computer simulations to examine the efficiency effects of reforms designed to reduce sales tax base erosion.\textsuperscript{7}

Trends underlying tax base erosion appear to be structural and likely to continue. Baumol (1967) argues there is a structural tendency for manufacturing productivity growth to exceed productivity growth in services, so relative prices of manufactured goods tend to decline.\textsuperscript{8} If demands for both goods and for services are inelastic, the services sector will tend to absorb ever-larger fractions of resources and increase in proportion to total value added. Recent evidence indicates that both taxed commodities (mostly tangible goods) and untaxed commodities (mostly services) are price inelastic (Russo and Wei 2004). Everything else held constant, therefore, the relative price decline in manufactured goods tends to reduce their share in total spending, supporting a continued shift toward services.\textsuperscript{9} Since older consumers spend relatively large fractions of income on untaxed medical services, aging of the population also could contribute to sales tax base erosion. As a result of the Interstate Commerce Clause, remote vendors often do not collect states’ general sales taxes. If Internet sales continue to grow rapidly relative to total purchases, e-commerce could exacerbate the problem.\textsuperscript{10} This possibility gains support from Goolsbee’s empirical work. His results indicate relatively large tax elasticities for Internet sales (Goolsbee 2000a).

To make matters worse, tax sensitivity appears to increase over time (Goolsbee 2000b).

Structural sales tax reform appears unavoidable. One possibility is to broaden the sales tax to more services. A variation on this theme would transform the sales tax to a true consumption tax. A third approach is to replace sales tax revenue with income taxes (Varian 2000).\textsuperscript{11} The first and second approaches attempt to shore up the sales tax base so that it adjusts automatically to shifts in the composition of spending and in the location of purchases. The third approach reduces erosion by

\begin{itemize}
  \item Many other factors contribute to base erosion, for example, legislators’ propensities to create tax exemptions. North Carolina recently exempted food purchased for home consumption from the state portion of its sales tax. See Bruce and Fox (2001) and Fox (2003) for helpful discussion of other contributing factors.
  \item The median state sales tax rate was 3% in 1970 (Bruce and Fox 2001). The Federation of Tax Administrators’ Web site indicates the median state rate was 5.5% on January 1, 2004. Merriman and Skidmore (2000) report empirical evidence indicating that increases in sales tax rates explain some of the observed substitution of services for tangible goods.
  \item The focus on efficiency does not diminish the importance of equity, administrative, and compliance issues. As the reader is aware, efficient policies tend to infringe on some notions of equity: Some efficient policies are simply not practical. The conclusion attempts to put these issues in perspective.
  \item Nordhaus (1997) reports that rapid productivity growth reduced the price of electricity and, therefore, relative spending on industrial production of light: The price declined even though light is an extraordinarily useful commodity. Results appear similar in agriculture: During the past century, productivity growth in agriculture has been high, prices have declined, and food spending has declined enormously as a share of total spending since demand for food is relatively inelastic.
  \item Between 1947 and 2002, the average price of taxed commodities fell by nearly 52% relative to the price of untaxed commodities. This calculation is based on Due and Mikesell’s (1994) and the Federation of Tax Administrators’ (1997) enumerations of taxed and untaxed commodities. See footnote 18 for a list of these commodities.
  \item See Bruce and Fox (2001) and McLure (2001) for discussion. McLure (2000) suggests that state income taxes have advantages over state sales taxes; however, he concludes that adjustment costs and the “tyranny of the status quo” probably prevent wholesale replacement of sales taxes by income taxes.
\end{itemize}
switching the tax base to one that appears less vulnerable to shifting consumption patterns. Each approach has features that could improve efficiency and features that could reduce it. Efficiency improvements could result from base broadening, which would result in lower tax rates (revenue held constant), and reducing existing distortions due to disparate tax treatment of goods versus services and brick-and-mortar versus remote sales.

However, taxing more services could reduce efficiency because firms spend substantial amounts on services (Fox and Murray 1988; Due and Mikesell 1994). To the extent that a tax on services falls on service inputs to production, distortions in production decisions could increase, increasing the excess burden of the tax system. A potential disadvantage of taxing e-commerce could occur because e-commerce consists predominantly in business-to-business transactions (Goolsbee and Zittrain 1999; Bruce and Fox 2004). Further, firms purchase tangible goods, including machinery and equipment, via e-commerce. The sales tax on these purchases increases the cost of capital and distorts investment decisions (Due and Mikesell 1994). Published empirical evidence indicates that capital input markets tend to be imperfectly competitive (Appelbaum 1982; Hall 1986; Domowitz, Hubbard, and Petersen 1987). Price markups appear particularly large in markets for machinery and equipment. With this in mind, Judd (1997, 2002) argues that policymakers should be particularly careful not to tax these inputs.

Replacing sales with income taxes could reduce efficiency because income taxes distort saving and investment decisions. Recent empirical work by Carroll et al. (2000) indicates that the personal income tax discourages small-business spending on machinery and equipment. Although state marginal income tax rates appear low relative to federal rates, by the square rule the two marginal rates together determine the excess burden of income taxes. Therefore, an increase in the relatively high state plus federal income tax rate could increase excess burden out of all proportion to the relatively small state income tax rate.

This paper uses a computable general equilibrium model to evaluate the efficiency of reforms designed to reduce base erosion. Simulations of the model indicate that (i) broadening sales tax bases could increase economic efficiency, (ii) moving to a consumption tax dominates base broadening, (iii) replacing sales taxes with higher income taxes could produce large efficiency losses, (iv) base broadening could generate efficiency gains even if untaxed remote sales become a “sizable” (25% in the simulations) fraction of total purchases, and (v) even partial base broadening could produce sizable efficiency improvements.

Section 2 describes the analytical model and the tax structure used in the simulations. The Ramsey model of long-run economic growth is used here. A long-run model is appropriate for the issues studied here because a substantial portion of sales tax base erosion stems from long-run secular trends. Income taxes, which could play a role in sales tax reform, affect capital accumulation and standards of living in the long run.12 A long-run model, therefore, should be informative on the issue. Section 3 reports on the simulation results and describes sensitivity analysis. Section 4 summarizes the main points, draws conclusions, and describes important qualifications.

2. The Model and Tax Structure

The Analytical Model

The model used for the simulations basically is a Ramsey long-run growth model augmented by a detailed tax structure and a monopolistically competitive sector for business inputs.13 Monopolistic

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12 For example, movement away from income taxation and toward consumption taxation tends to encourage capital accumulation.
competition is used here because empirical evidence suggests large markups on machinery and equipment (Appelbaum 1982; Hall 1986; Domowitz, Hubbard, and Petersen 1987). The model, which is described in detail in Appendix A, includes a household sector, a final output sector, and a business input sector.

The household sector includes equations describing the household budget constraint and preferences for saving, consumption of services, and consumption of tangible goods. The household first chooses how much to save and the level of current consumption and then decides how to divide consumption between services and tangible goods. The model’s parameters are calibrated so that the fraction of spending on services is 60% of total consumption spending, which is approximately equal to the proportion of untaxed personal consumption spending observed in the United States recently. This part of the model conforms to the life cycle hypothesis: Saving is chosen optimally to smooth consumption over the lifetime. Households use saved funds to purchase ownership titles to physical capital. Also, firms choose investment in physical capital optimally to maximize the present discounted value of owners’ shares.

The final output sector includes an equation describing firms’ after-tax cash flows from purchasing inputs and producing and selling output. Given the wage rate and the price of business inputs, final output producers choose how much labor and business inputs to employ. The final output sector, the labor market, and the physical capital market are perfectly competitive.

The business input sector includes an equation describing firms’ after-tax cash flows. Input producers purchase physical capital from households and use the capital to manufacture business inputs. Since the business input sector is monopolistically competitive, input producers choose the price to charge for inputs, which are sold at a markup over marginal cost. Input producers also choose how much capital to employ.

The efficiency of tax reforms can be affected by the openness of the economy. The U.S. states are small, open economies. A central feature of small, open economies is that posttax interest rates and posttax commodity prices are fixed by world markets, so economic policy in small economies cannot alter posttax returns or prices. The Ramsey model used here does not incorporate a separate set of equations for separate economies. Nevertheless, the model reflects the central economic features of open economies required to evaluate efficiency effects of reforms designed to reduce sales tax base erosion.

To see this, assume the world economy is in equilibrium. Now suppose government in economy X increases its tax rate on capital income. Initially, X’s posttax interest rate declines, causing capital to migrate to locations where the interest rate remains higher. In order to restore equilibrium, X’s pretax interest rate must rise sufficiently to deliver the unchanged world posttax interest rate. Since the capital stock in X ends up smaller than it otherwise would have been, the tax increase reduces efficiency. The same effect occurs in the Ramsey model, although the mechanism differs slightly. To see this, suppose government in a Ramsey economy increases the tax rate on capital income. As before, the posttax interest rate initially declines. Capital migration occurs here also, but this time the migration takes the form of a decline in saving. In order to restore long-run balanced growth, capital in the tax reform economy must decline—and the pretax interest rate must rise—sufficiently to deliver savers’ unchanged posttax required rate of return. Since the capital stock in the Ramsey model ends up smaller than it otherwise would have been, the tax increase reduces efficiency, as in an open state economy model.

Open economies trade commodities as well as capital. Thus, aside from transactions costs and uncertainty, posttax commodity prices must be the same everywhere. Suppose that in the initial equilibrium state, sales tax rates are equal, so there are no tax reasons to cross state lines to shop. Now
suppose economy $X$ increases its sales tax rate. Initially, the posttax price increases, causing shoppers to cross state lines to obtain lower posttax prices. The decline in demand would cause $X$’s pretax prices to decline until markets are in equilibrium at equal posttax prices. The inefficiency arises because the same products are sold at different tax rates at different locations. Tax treatment of remote sales in the simulations in this paper generates the same type of inefficiency. Initially, the economy is in equilibrium with zero remote sales, and all retail purchases are taxed at the same rate. Then untaxed remote sales are introduced, allowing a product to be purchased “in state” at a positive tax rate, while the same product can be purchased “out of state” tax free.\footnote{Fisher (1996) and Fox (2003) equate remote sales and cross-border shopping.} The qualitative implications for efficiency are the same in the two cases.

Labor can migrate across open borders in response to income taxes. Ceteris paribus, cross-border disparities in income taxes cause workers to favor locations where tax rates are lower. Labor is not mobile in the Ramsey model used here. This is an issue in two tax experiments reported here, namely, reforms 4 and 5. In reform 4, the income tax rate increases, producing the least efficient result. In reform 5, the income tax rate decreases, producing the most efficient result. If labor mobility were incorporated in the model used here, reform 4 would appear less efficient than it does, while reform 5 would appear more efficient. Thus, including mobile labor would make the model more complex without altering the paper’s conclusions.\footnote{For a model with endogenous labor, see Russo (2004).} The principle of parsimony argues for the simpler model.

**Basic Tax Structure in the Model**

This section describes the tax structure embedded in the simulation model. The incredible diversity in actual state and local tax systems would make quantitative analysis intractable, so some choices must be made. A considerable amount of detail of actual tax systems is excluded because it has no bearing on the issues studied here.

The government levies a personal income tax on household wages and interest income. The personal income tax is a proportional tax with no exemptions or deductions. For equity reasons, many states employ graduated income tax rates to make taxes more progressive than otherwise. However, the use of proportional taxes in the simulations will not affect the relative ranking of the reforms studied here. This analysis finds that replacing the sales tax with a higher proportional income tax rate is relatively inefficient. Revenue held constant, a graduated income tax system requires a higher marginal tax rate on high-income households than is required in a proportional system. Thus, including a graduated income tax would make replacement even less efficient and would not alter the conclusions.

The noncorporate business sector generates about 20% of all production. The model assumes noncorporate business firms pay the proportional personal income tax. Corporations pay a proportional income tax on corporate cash flows. Cash flow is defined as gross receipts minus wages, debt service, and capital depreciation. The corporate income tax is assessed on 80% of cash flow.

**State and Local Tax Facts, and Calibration of the Model**

Forty-five states levy general sales taxes.\footnote{The District of Columbia levies a sales tax at 5.75%. Unless otherwise indicated, this discussion is based on information provided in Federation of Tax Administrators (2004).} The exceptions are Alaska, Delaware, Montana, New Hampshire, and Oregon.\footnote{However, in Alaska, counties can levy sales taxes up to 7%, and cities and boroughs can levy sales taxes to 6%.} In early 2004, the lowest state sales tax rate was 2.9%, in Colorado. The
highest state sales tax rate was 7%, in Mississippi, Rhode Island, and Tennessee. State sales tax revenue, averaged across states, was about 42% of total (i.e., sales plus personal and corporate income) state tax revenue. The state sales tax was calibrated to deliver this value. As a result, the state sales tax rate initially is set equal to 5% in the simulations. Local sales taxes are levied in all but 11 states. The highest local sales tax rate was 7%, in Alabama, Alaska, and Colorado. The highest combined, state plus local sales tax rate was 11%, in Alabama. State plus local sales tax revenue, averaged across states, was about 49% of total (sales, income, and property) state and local tax revenue. The state plus local sales tax rate was calibrated to deliver this value. Thus, in the simulations, the state plus local sales tax rate initially is set equal to 7%.

Only Hawaii, New Mexico, South Dakota, Delaware, and Washington tax most services. However, Due and Mikesell (1994) and the Federation of Tax Administrators (1997) show that discrimination in state sales taxes is not a simple separation into taxed tangibles and untaxed services. A careful reading of those sources indicates that untaxed commodities make up about 60% of total personal consumption expenditures. The utility function in the simulation model reflects relative preferences for goods and services and is calibrated to deliver this value.

There is overwhelming diversity in sales taxes on business inputs. Most sales tax states exempt goods purchased for resale. The usual interpretation is that any good that becomes a component part, or a physical ingredient in production, represents a sale for resale and is exempted. Twenty-four states offer general exemptions for goods consumed in the production process, that is, goods used in production that do not become component parts, such as fuel. Only 18 states tax electricity used in production. Many states offer at least partial exemptions for equipment and machinery. Nevertheless, the sales tax falls on a substantial proportion of business-to-business transactions. Ring’s (1999) estimates indicate that about 41% of the statutory incidence of state sales taxes falls on business inputs, the remaining 59% deriving from sales of final commodities: These values are used in the simulations. Tax treatment of remote (i.e., out-of-state) vendors’ sales have been a point of controversy for sales taxes for a long time. Remote sales have become even more of a focal point since the advent of the Internet. Internet sales of tangibles generally are untaxed, while sales of vendors with nexus in a state generally are taxed. Bruce and Fox (2004) report on Forrester Research Inc. estimates indicating that about 95% of Internet sales are business-to-business, so the model uses this value.

All but seven states and the District of Columbia levy personal income taxes. The exceptions are Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming. Most state income taxes use graduated marginal tax rates. In early 2004, state personal income tax revenue, averaged across states, was about 44.7% of state and local revenue from income and general sales taxes. The

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18 Tangible goods generally not taxed are (using Bureau of Economic Analysis headings) ophthalmic products and orthopedic appliances, food purchased for off-premise consumption net of alcoholic beverages for off-premise consumption (which generally are 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 U.S. residents net of personal remittances in kind to nonresidents). Services generally not taxed are housing net of transient hotels, motels, and other traveler 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 U.S. residents net of expenditures in the U.S. by nonresidents). The referee points out that building materials generally are taxed, and some states tax construction and repair services. Therefore, the fraction of spending untaxed is somewhat less than this simple calculation suggests.

19 The model does not distinguish between mail-order sales and Internet sales. Most recent discussion concentrates on Internet sales, so the remainder of the paper focuses on them.

20 Most states impose the use tax on purchases from out-of-state vendors, not otherwise subject to sales tax. However, compliance is widely known to be very weak.

21 However, New Hampshire and Tennessee tax only interest and dividend income.
personal income tax rate is calibrated to deliver this value. Thus, in the simulations the state personal income tax rate initially is set equal to 2.5%. With the exception of South Dakota, all states and the District of Columbia levy corporate income taxes. Rates vary greatly, with the highest, 9.99%, in Pennsylvania. However, as a result of deductions for debt service and accelerated depreciation, effective marginal income tax rates tend to be far less than statutory rates (see Gravelle 1994). In early 2004, corporate income tax revenue, averaged across states, was about 6% of total state and local tax revenue. To deliver this value in the simulations, the corporate income tax rate is set equal to 1%. However, corporate taxes do not play an important role in the reforms examined here, and the sensitivity analysis indicates that the corporate rate does not affect the results.

The solution of the model requires numerical values for nine free parameters. For example, to solve the model, the value of a parameter representing preferences for services relative to tangible goods must be set. Appendix B describes the way parameter values were chosen.

3. Computer Simulations of Long-Run Effects of Sales Tax Reform

Five Reforms: Discussion

This paper studies efficiency effects of the following three basic approaches to reducing sales tax base erosion: (i) extending the sales tax to services, (ii) transforming the sales tax to a consumption tax, and (iii) replacing sales taxes with income taxes. This section provides more detail and describes two variations on these themes. The five “benchmark” reforms are given in the following sections.

Reform 1: Extend the Sales Tax

First and foremost, extending the sales tax to more services would tend to protect the tax base from erosion due to the shift away from tangible goods. As well, taxing services would tend to reduce excess burden resulting from the tax-induced distortion in the relative prices of tangible goods (Merriman and Skidmore 2000). In opposition to this beneficent effect, reform 1 also has a tendency toward increased excess burden: Taxing more services would tend to increase taxes on business inputs, distorting production decisions. Simulating reform 1 generates a measure of the net efficiency effect resulting from these opposing tendencies.

Reform 2: Rescind the Sales Tax on Tangible Business Inputs

Rescinding sales tax on business inputs would not protect the sales tax base per se. It is useful to consider this reform, however, first because it plays a role in any attempt to transform the sales tax to a consumption tax and second because the excess burden from taxing business inputs is of interest in its own right. The sales tax distorts business input decisions, particularly in the use of capital. Reform 2 would have two opposing effects on efficiency: (i) It would tend to reduce efficiency because it would narrow the tax base; revenue held constant, this would necessitate a higher tax rate. (ii) It would tend to improve efficiency first by removing the distortion in business inputs and second by reducing tax cascading. Removing the distortion in business capital inputs could have a large efficiency effect because capital tends to be sold in imperfectly competitive markets. Tax cascading causes the

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22 Most states provide a myriad of tax breaks, such as research-and-development tax credits and jobs and development tax credits.
effective tax rate to exceed the statutory rate, increasing excess burden, so reducing cascading would improve efficiency.

Reform 3: Transform the Sales Tax to a Consumption Tax

This is accomplished by extending the sales tax to all final goods and services while rescinding the tax on tangible business inputs. Consumption taxation combines the economic rationales for reforms 1 and 2.

Reform 4: Replace the Sales Tax with Higher State Personal Income Taxes

Since the income tax effectively taxes all consumption, it taxes services. Therefore, this reform would protect the total tax base from the shift toward services. In addition, repealing the sales tax would eliminate the excess burden caused by the current tax advantage to services. However, the income tax also falls on saving. This broadens the tax base, which generates a given amount of revenue at a lower tax rate. The lower rate per se tends to reduce excess burden. However, the income tax reduces the incentive to save and invest, which tends to increase excess burden, by the square rule. Because the effective income tax rate includes both the state and the federal marginal tax rates, increasing the state income tax rate could cause a disproportionate increase in excess burden.

Reform 5: Replace the Sales Tax with a Consumption Tax; Use New State Tax Revenue to Reduce the Income Tax Rate and New Local Revenue to Reduce the Local Sales Tax

The simulations indicate that reform 3 improves efficiency while generating sufficient revenue to lower the sales tax rate. They also indicate that replacing income taxes with sales taxes could improve efficiency. These results suggest possible large gains from combining the two approaches. Reform 5 studies this possibility.

Measurement

The model used here calculates the long-run effects of sales tax reform. The tables in this paper show simulated effects in sales tax rates, quantities demanded for goods and for services, the physical capital stock, the level of gross state product (GSP), and economic efficiency. Demand, the capital stock, and GSP are measured in real per capita units. Changes in these variables are shown in percent.

The equivalent variation produced by tax reform is used to calculate the efficiency, or welfare, effects. The equivalent variation of a tax is the maximum one would pay to avoid the tax.23 As is usual in computational welfare analysis, equivalent variation is reported in units of real consumption per capita. A substantial fraction of sales tax base erosion is structural. Therefore, the policies studied here are equal-revenue structural tax reforms: In each simulated reform, tax rates adjust to maintain pre-reform revenue.24 Since revenue is constant, there are no income effects: The changes in welfare

23 See Auerbach (1985) and Creedy (1998) for discussions of welfare measurements.
24 Government spending in this model is a private good used for government consumption. Since the simulations are revenue neutral, government spending has no efficiency effects. For a simulation model with productive government infrastructure, see Russo (2004).
reported below result from substitution effects only, so they represent changes in the excess burden of the tax system.

**Benchmark Simulations**

This section assumes remote sales are a negligible fraction of total sales and studies the effects of “comprehensive” reform. Comprehensive reform applies to 100% of a tax base. For example, comprehensive reform of the sales tax exemption for food would extend the tax to 100% of food purchases.

Reform 1 in Table 1 extends the sales tax to all commodity purchases. Column II in the table shows the sales tax rate declines to 2.8% (recall that the prereform value was 7%). The tax rate declines by a large amount because services (more precisely, untaxed commodities) are a relatively large fraction of consumption spending (60%), so the tax base increases by a large amount. Reform 1 removes an existing distortion in the price of goods, so demand for goods increases (column III) and demand for services declines (column IV).\(^25\) Columns V and VI indicate reform 1 does not affect the physical capital stock or GSP. This is expected because taxing services has little or no effect on incentives to save and invest. Column VII indicates excess burden declines by an amount equivalent to 0.11% of real consumption.

Due and Mikesell (1994) describe a tax policy dilemma: Sales taxes distort business input decisions, which is inefficient. But removing sales taxes from business inputs would reduce revenue, which would require higher distorting tax rates. This leaves open the question, Which tendency would affect efficiency more, the removal of the distortion to business inputs or the increase in distortion from higher tax rates? The net effect is difficult to measure empirically. The simulation model provides an answer. Reform 2 removes the sales tax on tangible business inputs. This reform reduces the tax base, so the sales tax rate increases to 8.3%. The increase in the sales tax rate increases the relative price of tangible goods, so demand for goods declines and demand for services rises. By itself, this would increase excess burden. However, reform 2 also removes the distortion to business inputs, increasing the return on physical capital used in production and the physical capital stock and the level of GSP. On net, excess burden declines slightly.

Reform 3 simultaneously extends the sales tax to all final goods and services and removes the sales tax from tangible business inputs, transforming the sales tax to a consumption tax. This has two opposing effects on revenue. Hellerstein, Hellerstein, and Youngman (2001, p. 864) make a conjecture about the net revenue effects. They state, “Such a reform would lead not only to an expansion of the tax base to previously untaxed services, it would almost certainly lead to an increase in nominal tax rates to offset the decrease in revenues from business purchases that now constitute roughly 40% of the sales tax base.” Table I indicates this conclusion is too pessimistic. In reform 3 the tax rate declines substantially. Note that the changes in demand for goods and services equal the changes from reform 1, while the increases in capital and GSP equal those of reform 2. Both effects provide efficiency gains, so excess burden declines substantially.

Reform 4 replaces the state and local sales tax with a larger personal income tax rate. The income tax rate rises to 5.3% (recall that the prereform value was 2.5%). Eliminating the sales tax removes the existing tax advantage for services, so demand for goods rises relative to demand for services. However, increasing the income tax rate reduces the after-tax return on saving and investment, discouraging saving and decreasing the physical capital stock and GSP in the long run. The net effect

\(^{25}\) Demand for services declines as a fraction of total spending. Absolute demand may not decline, however, since total spending continues to grow, as income grows along the economy’s long-run growth path.
Table 1. Effects of Benchmark Reforms

<table>
<thead>
<tr>
<th>Tax Reform</th>
<th>II Postreform Tax Rates</th>
<th>III Δ D Goods</th>
<th>IV Δ D Services</th>
<th>V Δ K</th>
<th>VI Δ GSP</th>
<th>VII Δ EB</th>
</tr>
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<tbody>
<tr>
<td>Reform 1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to all services</td>
<td>$\tau^{SLST} = 2.8%$</td>
<td>8.1%</td>
<td>(5.6%)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>(0.11%)</td>
</tr>
<tr>
<td>b) Adjust $\tau^{SLST}$ to maintain revenue</td>
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<td></td>
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<td>Reform 2</td>
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<td></td>
</tr>
<tr>
<td>a) Repeal $\tau^{SLST}$ on business inputs</td>
<td>$\tau^{SLST} = 8.3%$</td>
<td>(1.3%)</td>
<td>1.0%</td>
<td>1.7%</td>
<td>0.5%</td>
<td>(0.05%)</td>
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<tr>
<td>b) Adjust $\tau^{SLST}$ to maintain revenue</td>
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<td>Reform 3</td>
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</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to final services</td>
<td>$\tau^{SLST} = 3.3%$</td>
<td>8.1%</td>
<td>(5.6%)</td>
<td>1.7%</td>
<td>0.5%</td>
<td>(0.20%)</td>
</tr>
<tr>
<td>b) Repeal $\tau^{SLST}$ on business inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Adjust $\tau^{SLST}$ to maintain revenue</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Reform 4</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Repeal $\tau^{SLST}$</td>
<td>$\tau^{SLST} = 0.0%$, $\tau^P = 5.3%$</td>
<td>(7.6%)</td>
<td>(5.9%)</td>
<td>(1.4%)</td>
<td>(0.4%)</td>
<td>0.33%</td>
</tr>
<tr>
<td>b) Increase $\tau^P$ to maintain revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reform 5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to final services</td>
<td>$\tau^P = 0.3%$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Repeal $\tau^{SLST}$ on business inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Adjust $\tau^P$ to maintain state revenue</td>
<td>$\tau^{LSST} = 1.0%$</td>
<td>8.5%</td>
<td>(5.4%)</td>
<td>4.1%</td>
<td>1.3%</td>
<td>(0.55%)</td>
</tr>
<tr>
<td>d) Adjust $\tau^{LSST}$ to maintain local revenue</td>
<td>$\tau^{LSST} = 5.0%$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Delta$ indicates percentage change; $D$ is real per capita demand; $K$ is real per capita physical capital stock; $GSP$ is real per capita gross state product; $EB$ is excess burden, measured in real consumption per person; $\tau^{LSST}$ is the state plus local sales tax rate; $\tau^P$ is the sales tax rate; $\tau^P$ is the state personal income tax rate. Negative values are shown in parentheses. Initial tax rates are $\tau^{SLST} = 7\%$, $\tau^P = 2.5\%$, $\tau^{LSST} = 2\%$.

is a relatively large increase in excess burden. Most states have graduated marginal income tax rates. Revenue held constant, graduated tax rates tend to reduce efficiency since they require higher marginal tax rates at the upper end of the income distribution. Ceteris paribus, incorporating a progressive tax in the simulation would cause efficiency to decline by a larger amount than found here, so including graduated income taxes in the model would support the results reported here.

I believe the relatively large effects in reform 4 are very important. These large effects are not attributable to unreasonable values for parameters controlling the interest elasticity of saving. The intertemporal elasticity of substitution in this model is 0.5, near the middle of reported estimates (see Auerbach and Kotlikoff 1987, chap. 4). Summers (1981) shows that the intertemporal elasticity of substitution plays a very weak role in life cycle effects of capital income taxes. The relative effectiveness of reform 4 results from compounding. As a result, even small changes in saving can have large effects on the capital stock and consumption in the long run.26

It is interesting to note possible incidence effects from replacing a sales tax with higher personal income taxes. First, by statute, state income taxes do not appear to be as progressive as the federal income tax and, therefore, probably fall less on high-income earners than does the federal tax. As a matter of economic incidence, state personal income taxes are likely to be paid largely by workers in

26 The same type of result occurs with long-run growth rates: Because of compounding, small changes in growth rates can produce very large effects on the standard of living in the long run.
the short run since labor tends to be relatively immobile. However, most states levy their personal income taxes also on noncorporate business. In these cases the tax is paid by small-business owners, their employees, or their customers. Nevertheless, since capital is relatively mobile in the long run, the tax’s final resting place most probably is wages. Second, Poterba (1996) and Besley and Rosen (1999) report empirical evidence that retail sales taxes tend to be passed on to consumers. This is consistent with a seemingly widely held perception that state sales taxes are regressive. Putting the two points together, reform 4 could reduce regressivity in state taxes in the long run, but the effect could be smaller than might otherwise be supposed.

The structure of reform 5 is complicated. It is motivated by the previous results: Moving the sales tax structure toward consumption taxation (reform 3) improves efficiency and raises sufficient revenue to lower the sales tax rate substantially. The results reported in the last paragraph indicate that reversing reform 4 would improve efficiency. Thus, transforming the sales tax to a consumption tax and using new state sales tax revenue to lower the state income tax rate should reduce excess burden. However, relatively few local governments levy personal income taxes. Therefore, reform 5 uses additional local sales tax revenue to reduce the local sales tax rate. As a result of this reform, the state personal income tax rate declines to 0.3% (from 2.5%), and the local sales tax rate declines to 1% (from 2%).27 The changes in demands for goods and services are consistent with expectations. The physical capital stock and GSP increase by relatively large amounts; thus, excess burden declines by a relatively large amount, equivalent to a 0.55% increase in real consumption units. To put this number in perspective, consider North Carolina, with GSP of about 198 billion real dollars in 2001: An increase of 0.55% is equivalent to $1.1 billion of real consumption spending, or about 8% of the state’s 2001 operating budget.

**Taxing Sales of Remote Vendors**

Mail-order and Internet vendors generally do not collect a state’s sales tax unless they have physical presence in that state. Although mail-order sales now are relatively large, they are growing slowly (Goolsbee and Zitrain 1999). Internet sales are a smaller fraction of total sales but are growing much faster.28 Although estimates differ, Goolsbee (2001) and Bruce and Fox (2004) agree that Internet sales already are eroding sales tax bases.29

Internet-induced base erosion could be addressed by extending sale taxes to Internet sales. The simulations reported next are designed to gauge the effects of this possibility. A large fraction of online sales are business-to-business. The simulations assume 95% of Internet sales are business-to-business. Table 2 provides an illustration of what might be expected, assuming Internet sales constitute 25% of total purchases. In most states, services are relatively lightly taxed. Case 1 in the first row of Table 2 assumes this would remain true if sales taxes were collected on Internet sales. Here, the sales tax is extended to Internet sales of intermediate and tangible goods but not services. The tax base expands sufficiently to reduce the tax rate to 3.8%. Taxing Internet sales of tangible goods eliminates the tax bias against brick-and-mortar vendors of tangibles. However, since Internet sales are predominantly business-to-business, the tax distortion to tangible business inputs increases. On net, excess burden declines slightly.

27 The state sales tax rate is constant at 5%.

28 Forrester Research Inc. (2004) predicts Internet sales will be about 7% of total sales in 2004 and could grow at a 14% compound annual rate for the rest of the decade.

29 According to Goolsbee (2001), mail-order sales currently generate larger revenue losses. His estimates indicate that state tax revenue losses from e-commerce may be about $6.9 billion in 2004. Bruce and Fox (2001) estimate larger losses.
Table 2. Effects of Extending Sales Tax to Internet Sales

<table>
<thead>
<tr>
<th>Tax Reform</th>
<th>Postreform Tax Rates</th>
<th>Internet Sales 25% of Total Purchases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\xi^{SLST}$</td>
<td>$\Delta D$</td>
</tr>
<tr>
<td>Case 1</td>
<td>Extend tax to Internet sales of tangible goods, not services</td>
<td>3.8%</td>
</tr>
<tr>
<td>Case 2</td>
<td>Extend tax to Internet sales of services as well as tangibles</td>
<td>2.2%</td>
</tr>
<tr>
<td>Case 3</td>
<td>Extend tax to Internet sales of final tangibles, tax relief for business inputs</td>
<td>4.7%</td>
</tr>
<tr>
<td>Case 4</td>
<td>Extend tax to all final Internet sales, tax relief for business inputs</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

* See Table 1 for notes.

Case 2 indicates the effect of extending the sales tax to Internet sales of intermediate and final services as well as tangible goods. Both the tax rate and the excess burden decline by larger amounts than in case 1. Case 3 takes an intermediate step toward consumption taxation of Internet sales by extending the sales tax to Internet sales of final tangible goods but removing the tax from currently taxed business inputs. The tax rate declines by less than in case 1, but excess burden declines by more. Case 4 indicates the effect of moving to consumption taxation of all transactions by extending the sales tax to all Internet sales of final commodities and removing the tax from currently taxed business inputs: Excess burden declines by the largest amount in Table 2.

How should these results be interpreted? Case 1 suggests that taxing remote sales could permit a sales tax rate lower than otherwise, even if remote sales become 25% of total sales; however, the economic benefits are small because business inputs purchased on the Internet remain taxable. The remaining cases suggest that the economic benefits would be substantially larger if reform includes both taxing final services and “untaxing” business inputs.

Past experience suggests that policymakers might respond to Internet-induced base erosion instead simply by increasing sales tax rates. To gauge the increase in tax rates required to maintain current revenue, assuming no tax reform, the next simulation increased Internet sales as a proportion of total spending to 40%.\(^{30}\) When Internet sales are 10% of total spending, the average state sales tax rate must rise to 7.6% (not shown in tables). When Internet sales are 40% of total spending, the average state sales tax rate must rise to 10.6%, a 51% increase. Slemrod and Bakija (2004) argue that sales tax rates above 10% may lose revenue because tax avoidance tends to trump the higher tax rate.

**Sensitivity Analysis**

This section checks whether the results derived thus far are sensitive to assumptions underlying the benchmark experiments. Table 2 indicates efficiency gains from moving from zero taxation to

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\(^{30}\) I thank Donald Bruce for suggesting this experiment.
consumption taxation of remote sales, while assuming remote sales constitute a counterfactually large fraction of total sales. This differs from the basic reforms studied in Table 1, which indicates efficiency effects from various proposals while assuming remote sales do not exist. This leaves open the question, Will the efficiency effects found in Table 1’s reforms be altered by growth in Internet sales? The issue can be addressed by rerunning the Table 1 experiments while assuming remote sales are 25% of total purchases. Table 3 shows the results. Comparing Table 3 with Table 1, the economic effects of taxing services tend to decrease, as remote sales become larger. However, the changes are not large.

The experiments in Table 1 assumed reforms are comprehensive. Comprehensive reforms appear unlikely. For example, it is doubtful that medical services ever will be widely taxed. It also would be surprising to see state legislatures increase coverage of food for home consumption. These two expenditures constitute 24.9% of total personal consumption expenditures. The next set of results study partial reform: The sales tax is extended to cover only 25% of services and only 25% of preexisting sales tax on inputs is rescinded. As one would expect, the effects of partial reforms, shown in Table 4, are smaller than those of comprehensive reform.31 However, the declines are much smaller than 25%. A form of diminishing marginal returns is at work here. The incremental effects of small improvements in the tax system tend to be large but decline with the size of the reform. For example, if excess burden increases more than proportionately with tax rates, it must decrease less than proportionately when tax rates decline, so the size of efficiency gains decline. This suggests that the incremental benefit of comprehensive reform, over 25% reforms, would be unsatisfactorily small. More important, it suggests that substantial gains are achievable even by partial reform of the sales tax.

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31 It is unclear how to implement a partial switch from sales to income taxes, so Table 4 does not show results for reform 4.
Table 4. Sensitivity Analysis\textsuperscript{a}

<table>
<thead>
<tr>
<th>Tax Reform</th>
<th>Postreform Tax Rates</th>
<th>$\Delta D$ Goods</th>
<th>$\Delta D$ Services</th>
<th>$\Delta K$</th>
<th>$\Delta GSP$</th>
<th>$\Delta EB$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reform 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to 25% of services</td>
<td>$\tau^{SLST} = 5.0%$</td>
<td>$3.7%$ (2.5%)</td>
<td>$0.0%$</td>
<td>$0.0%$</td>
<td>$0.08%$</td>
<td></td>
</tr>
<tr>
<td>b) Adjust $\tau^{SLST}$ to maintain revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reform 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Repeal $\tau^{SLST}$ on 25% of business inputs</td>
<td>$\tau^{SLST} = 7.9%$</td>
<td>$(0.9%)$</td>
<td>$0.8%$</td>
<td>$1.2%$</td>
<td>$0.4%$</td>
<td>$(0.04%)$</td>
</tr>
<tr>
<td>b) Adjust $\tau^{SLST}$ to maintain revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reform 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to 25% of final services</td>
<td>$\tau^{SLST} = 5.8%$</td>
<td>$3.1%$ (1.9%)</td>
<td>$1.6%$</td>
<td>$0.5%$</td>
<td>$(0.15%)$</td>
<td></td>
</tr>
<tr>
<td>b) Repeal $\tau^{SLST}$ on 25% of business inputs</td>
<td>$\tau^{SLST} = 5.8%$</td>
<td>$3.1%$ (1.9%)</td>
<td>$1.6%$</td>
<td>$0.5%$</td>
<td>$(0.15%)$</td>
<td></td>
</tr>
<tr>
<td>c) Adjust $\tau^{SLST}$ to maintain revenue</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reform 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Extend $\tau^{SLST}$ to 25% of final services</td>
<td>$\tau^{SLST} = 5.8%$</td>
<td>$3.1%$ (1.9%)</td>
<td>$2.2%$</td>
<td>$0.6%$</td>
<td>$(0.25%)$</td>
<td></td>
</tr>
<tr>
<td>b) Repeal $\tau^{SLST}$ on 25% of business inputs</td>
<td>$\tau^{SLST} = 5.8%$</td>
<td>$3.1%$ (1.9%)</td>
<td>$2.2%$</td>
<td>$0.6%$</td>
<td>$(0.25%)$</td>
<td></td>
</tr>
<tr>
<td>c) Adjust $\tau^{SLST}$ to maintain state revenue</td>
<td>$\tau^{SLST} = 1.7%$</td>
<td>$3.1%$ (1.8%)</td>
<td>$2.2%$</td>
<td>$0.6%$</td>
<td>$(0.25%)$</td>
<td></td>
</tr>
<tr>
<td>d) Adjust $\tau^{SLST}$ to maintain local revenue</td>
<td>$\tau^{SLST} = 5.7%$</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} See Table 1 for notes.

Thus far, the model includes state but not federal income taxes. But the marginal federal plus state income tax rate is much higher than the state income tax rate alone. Jorgenson (1993, table 1–2) reports a federal marginal effective tax rate on corporate-source personal income of 19.1% in 1990 in the United States. Auerbach (1996) reports a federal average marginal tax rate on wage income net of payroll taxes of about 22% in 1990. The relatively large federal plus state marginal income tax rates could be important because of the square rule. To see if the combined federal/state income tax rates matter, the initial personal income tax rate in the simulations was increased to 22.5%. In this case, the effects of reforms 1, 2, and 3 are nearly unaffected (results not shown). However, when reform 4 is implemented at the higher income tax rates, the physical capital stock and GSP decline more than before, and the addition to excess burden doubles. When reform 5 is implemented at the higher income tax rates, the physical capital stock and GSP increase more than before, and the efficiency gain more than triples. This suggests the effects of reforms 4 and 5 reported in the tables could be substantial underestimates.

The model used here assumes imperfectly competitive input markets. This choice is based on empirical estimates indicating large price markups in equipment and machinery. However, other input markets tend to be more competitive. Therefore, the simulations were rerun, assuming competitive input markets. The relative rankings of the reforms are not affected by market structure. There are nine free parameters in the model, each requiring a numerical value in order to conduct simulations. Appendix B describes the way these parameter values were chosen. To check to see whether these choices affect the basic simulation results, the parameter values were allowed to vary over reasonable ranges. In each case the conclusions are the same: Although the sizes of the economic responses vary somewhat, the qualitative results are not affected by reasonable changes in parameter values. The central results also are insensitive to the corporate income tax rate and appear to be quite robust.\textsuperscript{32}

\textsuperscript{32} The sensitivity results described in the last two paragraphs are not shown here. They are available on request.
4. Conclusions

The fundamental policy problem addressed in this paper has its origin in the fact that state and local general sales and use tax bases are eroding. Policymakers have a number of options that could shore up state and local tax bases. Basically, these include broadening sales taxes to commodities society increasingly favors and produces or replacing sales taxes with income taxes. The policy problem addressed here is, Which approach is most efficient? The paper reports on computer simulations of efficiency effects. The central results are the following:

(i) Broadening sales tax bases could increase economic efficiency.
(ii) Moving to a consumption tax dominates base broadening.
(iii) Replacing sales taxes with higher income taxes could produce large efficiency losses.
(iv) Base broadening could generate efficiency gains even if untaxed remote sales become a sizable fraction of total sales.
(v) Even partial base broadening could produce sizable efficiency improvements.

The effects of all but one reform are robust to changes in specification and parameter values. The exception occurs if the federal income tax is included in the model. In this case, the negative effects from replacing sales taxes by higher income tax rates increase greatly.

What policy implications can be drawn? The simulations provide a measurement of the inefficiency of sales taxes on business inputs in the United States. The simulations find that removing taxes on inputs and extending taxes to services, that is, movement toward consumption taxation, not only reduces inefficiency but also increases revenue. Therefore, this approach has potential to efficiently make up for past base erosion as well as reduce future erosion. Perhaps most important, the simulations provide support for the view that even partial sales tax reform can have measurable beneficent effects. There are two forces at work here. One is diminishing returns in tax reform. Small changes could produce effects that are proportionately large relative to comprehensive reform. The second is that long-run effects can be large, even if short-run effects are not, because of compounding. This result is notable because experience indicates it is likely to be politically difficult for policymakers to extend sales taxes comprehensively. Medical services and food purchased for home consumption may not be viable candidates for sales tax coverage. The simulation results give cause for optimism because they indicate that not all services must be taxed to improve the efficiency of the sales tax and improve revenue prospects.

I believe these conclusions are likely to hold up in the face of the following qualifications. The computer simulation model is stylized, abstract, and necessarily based on behavioral, quantitative, and simplifying assumptions. The specific numerical measurements of reform effects are neither estimates nor forecasts. The important information consists in the directions of change and in the relative rankings of reforms. For example, reform 5 in Table 1 suggests a long-run increase in efficiency equal in value to about 1.1 billion real dollars, annually, in states similar to North Carolina. If a standard error for this point estimate were available, the confidence interval probably would be wide. Nevertheless, one can be confident in the qualitative conclusions listed in this paper because the sensitivity analysis does not disturb directions of change or the relative impacts of the reforms.

This paper does not address the important equity implications of tax reform. Three points appear relevant: (i) Repealing the sales tax and raising income tax rates probably would make the system more progressive, but the simulations indicate the cost in economic efficiency could be large. (ii) Whether extending the sales tax to services would affect progressivity may depend on
implementation. Calculations reported by Fox and Murray (1988) indicate that sales taxes in states taxing a high proportion of services tend to be regressive up to about $30,000 of household income.\textsuperscript{33} The more comprehensive is the extension of the sales tax, the less regressive reform is likely to be. (iii) The sales tax on food, particularly food purchased for home consumption, may be regressive. Many policymakers support exempting food from sales tax, apparently in hopes of reducing the tax burden on poor households. Hamilton and Whalley (1989) argue that targeted transfers, in place of the food exemption, would provide a more efficient mechanism to aid poorer households. The food exemption benefits middle- and upper-income households, who are not the intended beneficiaries. A transfer payment targeted on poor households would cost less revenue, permitting lower tax rates—for a given revenue requirement—which would be more efficient. For political reasons, targeted transfers may increase the likelihood reform will be approved since they could diminish the equity case against reform. When tax reform proposals must pass an equity test, the result tends to be unending debate, without resolution. When the evolution of the economy makes structural tax reform unavoidable, as it appears to have done in the case of state and local taxes, policymakers may be more likely to achieve success by adopting efficient structural reform and then modifying transfer programs to prevent deterioration in the welfare of poor households.

Administration and compliance costs increase the burden of taxes but are not included in the model. The sales tax on tangible goods appears relatively simple to administer and comply with: A sales tax on services is much more complicated.\textsuperscript{34} However, the social costs of the alternative (the income tax) appear so large in these simulations that it seems unlikely that including collection costs would affect the conclusion. As well, replacing a sales tax with an income tax would require establishment of local income taxes, which would impose administrative costs from shifting to the income tax. Again the results of the partial reform simulations give cause for optimism: Not all services need to be taxed. But not all services are equally difficult to collect tax on. This suggests that limited extension of sales tax to services could be efficient without placing undue burdens on design and administration.

The referee points out that the welfare effects of sales tax base broadening would depend on elasticities of specific goods and services newly brought into the tax base. For example, demand for food consumed at home and medical services tend to be inelastic, so extending taxes to these may have small effects. But the model and simulation results reflect elasticities only of the broad categories "goods" and "services." First, if demand for currently untaxed goods and services are inelastic, taxing them would tend to generate new revenue. If the reform is revenue neutral, tax rates can be lowered. In either case, marginal excess burden would tend to decline. Second, small uncompensated elasticities may mask large compensated elasticities, in which case efficiency effects would tend to be large even if responsiveness is not. Third, this point places emphasis on the value of simulations of partial reforms. It is unlikely that sales taxes ever will be widely applied to goods and services viewed as necessary for sustenance and the maintenance of life. The simulations suggest partial sales tax extensions could produce gains even if untouchables, such as medical services and food for home, are left untaxed.

The thrust of the results supports the view that fixing the sales tax would be a sound way to avert continued sales tax base erosion. And base broadening would generate revenue that could be used to

\textsuperscript{33} This estimate, which is based on 1984 data, is in nominal dollars. Given inflation since the mid-1980s, this translates into about $50,000 in today’s dollars. Fox and Murray (1988) conclude that taxing services is proportional for incomes exceeding $30,000 ($50,000 today).

\textsuperscript{34} See Fox and Murray (1988) and Hellerstein (1988).
reduce sales taxes on business inputs while lowering tax rates. This combination has the potential to increase efficiency while offering arguments that, effectively presented, could counter the political opposition any serious reform proposal is certain to face.

Appendix A

The model used in the simulations, basically, is a Ramsey growth model with the addition of a monopolistically competitive sector for business inputs and a robust tax structure. See Barro and Sala-i-Martin (2004) and Romer (2001) for detailed descriptions of the Ramsey model. See Romer (1990) for a description of the monopolistically competitive business input sector.

Household Consumption Decisions

This section derives the household’s first-order conditions for consumption of goods and services and the long-run growth rate in consumption. The following specification for the discounted value of lifetime utility permits a simple yet general representation of the household’s static choice between goods and services as well as its long-run dynamic consumption decision:

\[
V = \int_0^\infty e^{\alpha r} \left[ \beta g(t)^\theta + (1 - \beta) s(t)^\theta \right]^{\frac{1}{\theta - 1}} dt; \quad 0 < \beta < 1, \quad \psi < 1. \tag{A1}
\]

Here, \( n \) is the population growth rate, \( \rho \) is the subjective rate of time preference, \( \beta \) is a parameter describing the consumer’s intensity of preferences for goods versus services, \( g(t) \) is per capita spending on tangible goods at time \( t \), \( s(t) \) is per capita spending on services, and \( \psi \) determines the elasticity of substitution between goods and services, \( 1/1 - \psi \). To simplify notation, the index for time is dropped hereafter.

The per capita household flow budget constraint is

\[
\dot{k} = (1 - \tau^r)(kw + rk) - g(1 + \tau^s) - s(1 + \tau^s) - nk, \tag{A2}
\]

where \( k \) is the per capita physical capital stock, the overdot represents differentiation with respect to time, \( \tau^r \) is the flat tax on personal (noncorporate and individual) income, \( l \) is the fraction of time workers spend at labor, \( w \) is the real wage rate per unit of time, \( r \) is the pretax short-term interest rate, \( \tau^s \) is the sales tax rate on tangible goods, and \( \tau^s \) is the sales tax rate on services.

Equation A3 is the present value Hamiltonian for the household’s choices:

\[
H = e^{\psi r} \left[ \beta g^\theta + (1 - \beta)s^\theta \right]^{\frac{1}{\theta - 1}} + \lambda [1 - \tau^r] [(kw + rk) - g(1 + \tau^s) - s(1 + \tau^s) - nk], \tag{A3}
\]

where \( \lambda \) is the present value of an additional unit of capital at time \( t \). Setting derivatives of Equation A3 with respect to \( g \) and \( s \) equal to zero and taking the ratio of these two equalities gives the first-order condition for goods and services:

\[
\frac{\beta}{1 - \beta} \left( \frac{\lambda}{\lambda} \right)^{1 - \theta} = \frac{1 + \tau^r}{1 + \tau^s}. \tag{A4}
\]

The costate equation for the Hamiltonian is \( \partial H/\partial k = -\dot{\lambda} \).\textsuperscript{35} Using this and the fact that goods and services must grow at equal rates in the long run, the growth rate for consumption is

\[
\frac{\dot{s}}{s} = \frac{\dot{k}}{k} = (1 - \tau^r)r - \rho. \tag{A5}
\]

Production of Final Output, Demand for Business Inputs

To get the first-order conditions for final output, use the per capita production function,

\[
y = y^d + y^f = \rho x^{1-\alpha}; \quad 0 < \alpha < 1, \tag{A6}
\]

where \( y \) is the per capita flow of final output, \( \alpha \) is the elasticity of final output with respect to labor, and \( x \) is the per capita quantity of business input. Output can be consumed as services or as tangible goods. The way output is divided between these uses is determined by household preferences and taxes in Equation A4.

\textsuperscript{35} See Turnovsky (1995) for examples.
The cash flow of final output producers is \(36\)

\[
\pi = [NCB(1 - \tau^f) + CB(1 - \tau^c)][y - lw - fpx(1 + \tau^c bi)] - (1 - f)px(1 + \tau^c bi). \tag{A7}
\]

where \(\pi\) is cash flow; \(NCB\) is the fraction of output produced by the noncorporate business sector and, therefore, taxed as personal income; \(CB\) is the fraction of output produced by the corporate sector; \(\tau^c\) is the corporate income tax rate; \(f\) is the fraction of business inputs financed by debt, which is tax deductible; \(p\) is the price of business inputs; and \(bi\) is the fraction of sales tax revenue from taxation of business inputs. Note that the first term in square brackets in Equation A7 is a weighted average retention (WAR) rate for producers’ cash flow, where the weights are the fractions of output produced in the noncorporate and corporate sectors. To simplify, define \(WAR = [NCB(1 - \tau^c) + CB(1 - \tau^c)]\).

The first-order conditions for \(l\) and \(x\) equate posttax marginal revenue and posttax marginal cost:

\[
\alpha p^{-1}x^{1-\alpha} = w, \tag{A8a}
\]
\[
WAR(1 - \alpha)\frac{d^x}{d \alpha} = p(1 + \tau^c bi)(fWAR + 1 - f). \tag{A8b}
\]

**Price of Business Inputs**

To get the price of business inputs in the simplest possible way, assume that one unit of physical capital is transformed into one unit of \(x\). The input sector is monopostatically competitive, so input producers choose \(p\) to maximize

\[
\pi = WAR(px - (fr + \delta)x) - (1 - f)px, \tag{A9}
\]

where \(\delta\) is the rate of economic depreciation of physical capital. Use the inverse demand for durables in Equation A8b to replace \(p\) in Equation A9, set the derivative with respect to \(x\) equal to zero, and solve for \(p\) to get

\[
p = \frac{(1 - f)r + WAR(fr + \delta)}{WAR(1 - \alpha)}. \tag{A10}
\]

**The Government’s Flow Budget Constraint**

The government’s flow budget constraint is

\[
TR = \tau^g + \tau^s + \tau^px(bi) + \tau^d [lw + rk] + (NCB\tau^d + CB\tau^c)[y - lw - fpx(1 + \tau^c bi) + x(p - (fr + \delta))], \tag{A11}
\]

where \(TR\) is tax revenue. The first three terms of Equation A11 are revenue from sales taxes on goods and services. The fourth term is revenue from the personal income tax on wage and interest income. The fifth term is revenue from the personal and corporate taxes on business income.

**Appendix B**

The Solve function in Mathematica 5.0.1 software is used to solve the model. In the benchmark simulations, the parameters of the model are given the following values: \(\rho = 0.034, \alpha = 0.7, \beta = 0.06, g = 0.0175, n = 0.01, f = 0.33, NCB = 0.2, \psi = 0.5, bi = 0.41, CB = (1 - NCB), \) and \(\beta = 0.47\). Of these, only the first nine are free since the value of \(CB\) is determined by the value chosen for \(NCB\), and \(\beta\)’s value is determined by the value chosen for \(\psi\). Nearly all the free parameters have been reported in the empirical literature and used extensively in simulations. The term \(\psi\) has not been reported. The proper way to address this uncertainty is to conduct a careful sensitivity analysis to check that the simulation results are not artifacts of assumed parameter values. An extensive sensitivity analysis indicates the simulation results are robust to reasonable changes in parameter values.\(^{37}\)

The value for the subjective rate of time preference, \(\rho\), is taken from Lucas (1990). Labor’s share of final output production, \(\alpha\), is set to equal the historically observed value of output earned by labor, 0.7. Stokey and Rebelo (1995) suggest a realistic value for the depreciation rate, \(\delta\), is 0.06, so this value is used in the simulations.

U.S. growth in output per worker has averaged about 1.75% per year over more than a century (Barro and Sala-i-Martin 2004), so this value is used for \(g\). The population growth rate, \(n\), is set equal to 1.0%. Tables 10-1 and 10-2 in Fullerton and Karayannis (1993) indicate U.S. industry financed slightly more than 33% of capital from debt in 1990. Gravelle (1994) says this number is a useful rule of thumb for the level of debt-financed capital. Therefore, the proportion of debt-financed capital in the final output sector, \(f\), is set equal to 33%. Table 1 in Gravelle and Kotlikoff (1989) indicates that 76% to 86% of output was

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\(^{36}\) The cash flow equation is actually more complicated than Equation A7 because tangible business inputs may be taxed differently than service inputs. Taking this distinction into account here would complicate the presentation without changing the substance. Therefore, \(\tau^c\) is used here for the sales tax on business services and on tangible inputs.

\(^{37}\) Some of the sensitivity results are reported here. A presentation of all sensitivity results is available on request.
produced by the corporate sector in the United States between 1975 and 1982. The computer model assumes that 20% of production is produced by the noncorporate sector (NCB = 0.2) and is subject to the personal income tax rate, while the remainder is produced by the corporate sector (CB = 0.8) and is subject to the corporate income tax rate.

Empirical values are unknown for $\psi$, which controls the elasticity of substitution between goods and services (namely, $1/(1 - \psi)$) and $\beta$, the relative intensity of preferences for goods and services. However, $\psi$ and $\beta$ determine the fraction of household consumption spending on untaxed commodities, which is about 60% of personal consumption spending. To deliver this value, $\psi$ is set equal to 0.5, and $\beta$ is set equal to 0.47. In the sensitivity analysis, $\psi$ is allowed to vary from −2.0 to 0.9, while $\beta$ is adjusted to maintain a ratio of untaxed commodities to consumption spending equal to 60%. This does not affect the results. Initially, $bi$, the fraction of sales tax revenue resulting from taxation of business inputs, is set to equal to 41%. This is the average value, across all states, estimated by Ring (1999). Ring also reports that the highest value is 72% and that the lowest value is 11%. Allowing $bi$ to take these values does not affect the paper’s conclusions.

References

Fox, William F. 2003. Three characteristics of tax structures have contributed to the current state fiscal crises. State Tax Notes, August 4, 375–83.

38 Coincidentally, $\psi = 0.5$ is the value used in the basic simulations in Hamilton and Whalley (1989), although that is not the reason 0.5 is used here.


