ABSTRACT. A state-level computable general equilibrium (CGE) model was used to
investigate economic adjustment to a property tax limitation in Oregon. Findings under two
CGE model variants are compared with results using a fixed-price, input-output type model. The
analysis suggests that: (1) total output and income increase under the limitation, with high-
income households benefiting most and low-income households least; (2) even with income
growth, total state and local government tax revenues and spending shrink significantly; (3) the
limitation makes Oregon’s tax system slightly less progressive at the top of the income
distribution but slightly more progressive at the bottom. (JEL R51)

I. INTRODUCTION

The passage of Proposition 13 in California in 1978 precipitated a wave of voter
initiatives and legislative actions to reduce tax growth. Particularly in states with voter initiative
processes, the tax limitation movement continues to push for voter approval of increasingly
stringent limits on state and local taxes. In some states, recent efforts to significantly modify the
tax system are driven by school finance reform, often reducing property taxes in exchange for
higher taxes on income or sales. Voter distrust of government, concern about rising taxes and
court-ordered equalization of school funding make it likely that tax limitation measures and state
/local tax reform will continue to occupy a prominent place on the agendas of state and local
policymakers.

Economic analysis of property tax limitations has focused primarily on the impact of
these limitations on tax revenues and the shifts in responsibilities between state and local
government (Cox and Lowery 1990; Elder 1992; Matsusaka 1995; O’Sullivan, Sexton, and
Sheffrin 1995; Preston and Icniiowski 1992). Analysis is usually limited to examination of the
direct effect of policy changes on tax revenue forecasts and interagency budget allocations.
Subsequent impacts, as economic agents adjust their behavior under the new policy climate,
receive relatively little attention, and very few studies have looked at the distributional impacts
of these measures (De Tray and Fernandez 1986; O’Sullivan, Sexton, and Sheffrin 1994).
Mieszkowski, however, called attention to the complex impacts of changes in public tax policy
on economic performance:
Associated with tax policy are a number of interrelated effects. Taxes have a direct impact on the level of effective demand and employment. Taxes affect work incentives, the amount of saving and the level and pattern of investment. Some taxes distort the allocation of resources and lead to inefficiencies. Finally, the level and structure of taxes determines the level of disposable income, and the distribution of after-tax income among different groups. (Mieszkowski 1969)

In this study we argue that Computable General Equilibrium (CGE) models represent a significant advance over fixed-price, input-output (IO) models for estimating these economy-wide effects, as well as for analysis of the fiscal impacts of a tax change. We demonstrate the ability of CGE models to incorporate impacts on the size distribution of household income. We also emphasize the importance of understanding how underlying modeling assumptions affect model results.

In this paper, a two-sector, state-level CGE model is used to investigate the impact of Oregon’s 1990 property tax limit, Ballot Measure 5. Estimates of general equilibrium adjustments in output, income, government revenues, and other variables are generated. Special attention is given to estimating changes in the size distribution of household income. Results and implications for income equity and public policy are presented and compared with a fixed-price IO model.

In the second section of the paper, we discuss Measure 5. In the third section we review the development of regional CGE models and discuss their application to tax analysis. The fourth section introduces the Oregon CGE model used in the analysis. A fifth section presents the results of our analysis of Measure 5 using the Oregon CGE model. In a final section, we discuss implications of this analysis and review some caveats in using the CGE approach for tax policy analysis.

II. OREGON’S PROPERTY TAX SYSTEM AND MEASURE 5

Over the past several decades, state and local taxes in Oregon, consisting primarily of taxes on income and real property, have remained a relatively constant, approximately 11 percent, share of personal income. Property taxes fluctuated between 4.5 and 6 percent of personal income during that time and were about 5.2 percent of income in 1990 when Measure 5 passed.

Yet voters had become increasingly dissatisfied with the perception of high and growing property taxes. Wages in Oregon were stagnant during the 1980s. The wood products industry, long a major base of the state’s economy, was in the process of downsizing employment. Voter surveys showed increasing skepticism about government, and citizens increasingly believed that much government spending was wasted. Oregonians, who had rejected property tax limits five times between 1978 and 1986, finally passed Measure 5 in 1990.

Measure 5 did two things: (1) it placed new limits on local property taxes; and (2) it required the state to replace (from the state general fund) revenues lost to schools because of the rate limit. The measure places limits on tax rates on an individual property. The limit for all nonschool local governments (counties, cities, and special districts) is $10.00 per $1,000 assessed value. The limit for schools (school districts and community colleges) phases in over a five-year period, starting at $15.00 per $1,000 assessed value in 1991–92 and lowering to $5.00
per $1,000 in 1995–96. Voters cannot override these limits, but specific bond levies are exempt. If the school or nonschool tax rate limits are exceeded, taxes must be reduced proportionately for each local government, thereby reducing the tax revenues each affected local government receives.

As noted, Measure 5 also shifts major responsibility for funding K–12 education to state government. Schools are funded primarily by local property taxes and state aid. As school property tax reductions are phased in, the state general fund is responsible to replace property tax revenues lost to schools.2

III. THE CASE FOR GENERAL EQUILIBRIUM ANALYSIS

The array of tools available to policy analysts includes econometric forecasting models and fixed-price, multi-sector simulation models. Econometric models combine statistically estimated parameters with exogenous estimates of U.S. economic trends to forecast response to policy shocks. Regional econometric models are commonly criticized for their reliance on forecast national trends as exogenous input variables. The use of incomplete accounting treatments (i.e., receipts not necessarily equal to expenditures) also limits the opportunity for theoretically consistent interpretation of results. Since the main concern is to forecast aggregate indicators of economic performance, this methodology is also generally unsuited to examination of the influence of public policies on selected industries or the distribution of regional household income.

Fixed-price IO models and Social Accounting Matrices (SAMs) provide internally consistent representations of regional economic structure. Although the perspective is general equilibrium, the accompanying assumptions are very restrictive. Unlike econometric models, fixed-price models can incorporate a complete accounting of factor payments to regional household income, thus enabling examination of income distribution issues. Designed to estimate the economy-wide impacts of changes in final demand, fixed-price models are limited in their applicability to analysis of supply-side phenomena and taxation/revenue policy. Among the restrictive assumptions used in fixed-price models are fixed-proportion production and consumption functions, unconstrained factor and commodity supply relationships, and fixed or price-inelastic demand for goods and services. In general, these assumptions produce estimates which provide, at best, upper-bounds on regional supply response to exogenous disturbances (Harrigan and McGregor 1989) and are prone to errors in the direction of change of endogenous variables.

CGE models combine some of the advantages of econometric and IO models, strengthening the theoretical basis of the modeling effort and enabling examination of a wider set of policy issues. The structure of a CGE model is consistent with modern neoclassical economic theory, incorporating factor and commodity substitution into the structure of production and demand. A CGE model consists of a Walrasian system of equations representing the clearing of factor and commodity markets resulting from optimizing behavior of economic agents and institutions. Endogenous prices adjust until factor and commodity market equilibrium conditions are satisfied, consistent with endogenous factor incomes. After calibration using base year data,

2 However the state is not bound to continue previous levels of support provided under the Basic School Support Fund (which in 1990-91 provided 24 percent of elementary and secondary school funding).
the system can simulate economic response to changes in policy variables vis-à-vis a base scenario.

Compared with fixed-price IO and econometric forecasting models, CGE models can better address the implications for efficiency and equity of alternative public policies because the underlying assumptions regarding economic behavior are more tenable. The enormous flexibility of possible CGE specifications accommodates a wide range of policy variables and adjustment periods. Incorporation of relative factor prices and factor substitution allows a more accurate treatment of the impact of government policies on factor markets and on the distribution of income among regional households. In addition, if factor endowments are assumed fixed, the relative efficiency of regional factor utilization can also be compared.

The recent development of accessible, numerical solution algorithms, especially GAMS (General Algebraic Modeling System—see Brooke, Kendrick, and Meeraus 1988) and GEMPACK (Dixon et al. 1992) stimulated an explosion of CGE-based research beginning in the early 1980s (Dervis, de Melo, and Robinson 1982). A survey by Shoven and Whalley (1984) describes 18 applications of CGEs to tax and trade policy issues. Pereira and Shoven (1988) have also surveyed applications of CGEs to national tax policy analysis.

At the national level, data for constructing CGEs is drawn primarily from National Income and Product Accounts, Input-Output accounts, and consumer expenditure surveys. Application of CGE methodology to regional (subnational) issues was hampered by limited availability of comparable data. However beginning in the late 1980s, regional accounts generated by IMPLAN (Alward et al. 1989) and supplemented with data from other secondary sources (e.g., Bureau of Economic Analysis; Census of Manufacturing) were successfully used to construct CGEs for Oklahoma (Koh 1991; Koh, Schreiner, and Shin 1992) and Southern California (Robinson, Subramanian, and Geoghegan 1993). More recently, software for converting IMPLAN regional data into GAMS readable code has been made available by Minnesota IMPLAN Group (MIG). The data and technology to build regional CGE models for policy analysis is thus becoming increasingly available.3

General equilibrium tax incidence analysis has traditionally examined “revenue neutral” scenarios, where government activity is held fixed in real terms, and the direct incidence of taxes is shifted from one set of economic factors to another. Balanced budget incidence analysis, in which government activity is allowed to shrink, is clearly more relevant for determining impacts of tax limitations. However as government activity is allowed to change, the difficulty of valuing different “sizes” of government complicates the analysis and precludes comprehensive welfare comparisons (Ballard et al. 1985).

This study is a general equilibrium analysis of Oregon’s Measure 5 property tax limitation. It is a balanced budget incidence analysis in which government budgets and taxes are allowed to shrink, as required by the Measure. Using a CGE model of the Oregon economy, we pay particular attention to the impact of the property tax limitation on the after-tax distribution of income, the progressivity of the state-local tax system, and federal-state-local government fiscal flows.

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3 Regional CGE models have also been constructed for Iowa, Ohio, Nevada, Virginia, and Washington.
IV. THE OREGON CGE MODEL

In the Oregon CGE model, there are two sectors, one producing “goods” and the other producing “services.” Essentially the model is static. Firms are assumed to produce under conditions of constant returns to scale, and to maximize profits in perfectly competitive markets. Three income classes of households are assumed to maximize utility subject to household income constraints. Each household income class has a different consumption pattern: regional product and factor markets clear through variation in regional factor and product prices. These markets are assumed to be insulated, to some degree, from national markets depending upon the ease of substitution between regional and national products in a given market. There are three government sectors, each with characteristic sources of tax revenues and spending patterns. Separation of federal, state-local school, and state-local nonschool government functions allow analysis of intersectoral tax and spending impacts.

The length of run is intermediate to long run. Labor is assumed to adjust across sectors according to changes in factor demand, and in the long run is assumed to be perfectly mobile across regions. Corporate capital and proprietors’ capital are allowed to be mobile across sectors but are fixed in total for the region. Investment does not feed into the capital stock, and no technical change is assumed. By the same token, the model takes no account of public capital and makes no attempt to measure public goods or productivity changes that may result from changes in government spending. Any intrinsic value that people might attach to public goods and services is also not accounted for in this analysis.

General equilibrium adjustments to Measure 5 are estimated using two different CGE model specifications, “neoclassical” and “Keynesian,” distinguished principally by alternative treatment of labor markets and savings-investment behavior. The third model is a fixed-price input-output model. Table 1 summarizes the main differences between the three models. In the neoclassical version, regional factor supplies and extra-regional financial flows are fixed, but factors are assumed to be freely mobile across sectors in the state economy. Factor return rates and investment are the endogenous equilibrating variables (Table 1). In the Keynesian version, labor’s wage and the level of investment are fixed. Total employment and the level of net financial inflows adjust to maintain equilibrium. Labor adjusts both intersectorally and interregionally (Table 1).

Both CGE models feature endogenously determined output, consumption, imports, exports, and commodity prices; exogenous spending by the federal government and by regional public schools; and revenue-driven spending on nonschool programs by regional governments. Findings under the two CGE models are also compared with an equivalent experiment using a fixed price, IO-type constant multiplier model. This version is based on a fixed proportion SAM model treating household income as endogenous. The fixed-price model thus incorporates more traditional assumptions regarding regional economic response, while the two flexible-price models accommodate a wider range of modeling assumptions, especially as they relate to limits on factor supply (Table 1).

Estimates of relative adjustments in output, income, government revenues, and other variables are presented. Effects on income distribution and, where applicable, economic efficiency are highlighted under the different modeling assumptions. Some implications of using different model specifications for analysis of regional fiscal policy are also discussed.

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4 A detailed description of the data, structure, and closure of the Oregon CGE model is available on request.
5 That is, the long-run supply of labor to the region is assumed to be perfectly elastic.
### TABLE 1
**MAIN FEATURES OF ALTERNATIVE REGIONAL MODELING SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Labor Supply</th>
<th>Other Factor Supplies</th>
<th>Savings-Investment Behavior</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoclassical CGE</td>
<td>Fixed Regional “Labor Supply; Endogenous Wage Rate”</td>
<td>Fixed Regional Supplies of “Capital” and “Proprietors”; Endogenous Factor Returns</td>
<td>Endogenous Investment Expenditures (determined by changes in Regional Savings)</td>
<td>All factors are intersectorally mobile</td>
</tr>
<tr>
<td>Keynesian CGE</td>
<td>Perfectly Elastic Regional Labor Supply; Fixed Wage Rate</td>
<td>Same as above</td>
<td>Fixed Investment Level (maintained by variation in flow of outside funds)</td>
<td>Same as above except “Labor” is also interregionally mobile</td>
</tr>
<tr>
<td>Fixed-Price IO</td>
<td>Same as above</td>
<td>Perfectly Elastic Regional Supplies of “Capital” and Proprietors; Fixed Factor Returns</td>
<td>Investment is assumed fixed (Exogenous Variable)</td>
<td>All factors intersectorally and interregionally mobile</td>
</tr>
</tbody>
</table>

### V. GENERAL EQUILIBRIUM IMPACTS OF MEASURE 5

The Measure 5 Shock

The impact of adopting the fiscal year (FY) 1996, fully phased in property tax rates is compared against the pre-Measure 5 baseline scenario. The Measure 5 shock directly reduces school property taxes for businesses by $636.1 million (–73.4 percent), and school taxes for households by $595.5 million (–74.5 percent), for an overall reduction in school tax revenues of 73.9 percent. Nonschool property tax rates, which are currently below the Measure 5 ceiling, increase marginally to take full advantage of the Measure 5 ceiling. Business property taxes thus increase by $23.7 million (5.4 percent) and household property taxes by $1 million (0.25 percent).

In response to property tax rate reduction under Measure 5, producers, consumers and government sectors adjust their economic behavior. Industry production costs are reduced and household incomes increase, but different models predict qualitatively different economywide responses. Results of the three simulations are presented in Tables 2 through 5. All variables are expressed as percentage change from base levels unless otherwise noted.
In the Keynesian CGE model, industries increase production of goods and services. This is facilitated by hiring more labor. Total output and exports increase (Table 2). Total absorption and imports also increase because, with increasing income, household consumption of goods and services (Table 3) outweighs the reduction in government expenditures (Table 4). In the Keynesian model expanded employment of labor increases regional value added by 1.25 percent (Table 5). Total incomes of low, middle, and high income households increase by 0.67 percent, 1.95 percent, and 2.09 percent, respectively (Table 3).

Under the neoclassical CGE specification, total supplies of labor, proprietors and capital are all regionally fixed (but mobile between sectors). Industries are thus less able to increase production by simply hiring more labor. Supply response is limited by increases in the marginal cost of labor and other factors. There is a slight reallocation of resources between goods and services industries, but the decline in real output of goods (-0.02 percent) exceeds the increase in services (0.01 percent) (Table 2). On the demand side total absorption and imports decline marginally (Table 2) because increases in consumption (Table 3) and investment (Table 2) do not quite offset reductions in government expenditures (Table 4). Despite a slight net decrease of 0.26 percent in total value added (Table 5), total household incomes increase for low, middle, and high income households by 0.27 percent, 0.79 percent, and 0.84 percent, respectively (Table 3), because the reduction in taxes outweighs the decrease in value added.

### Table 2

**Impact of Measure 5 on Industry (% Change)**

<table>
<thead>
<tr>
<th>Industry Aggregates</th>
<th>Keynesian CGE</th>
<th>Neoclassical CGE</th>
<th>Fixed-Price IO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goods</td>
<td>Servs</td>
<td>Goods</td>
</tr>
<tr>
<td>Total Absorption(^a)</td>
<td>1.20</td>
<td>1.41</td>
<td>-0.30</td>
</tr>
<tr>
<td>Output</td>
<td>2.50</td>
<td>1.54</td>
<td>-0.02</td>
</tr>
<tr>
<td>Imports</td>
<td>0.68</td>
<td>1.16</td>
<td>-0.43</td>
</tr>
<tr>
<td>Exports</td>
<td>3.04</td>
<td>1.81</td>
<td>0.11</td>
</tr>
<tr>
<td>Investment</td>
<td>0.37</td>
<td>0.63</td>
<td>1.38</td>
</tr>
<tr>
<td>Factor Demands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>3.28</td>
<td>2.27</td>
<td>-0.02</td>
</tr>
<tr>
<td>Proprietors</td>
<td>0.60</td>
<td>-0.38</td>
<td>-0.02</td>
</tr>
<tr>
<td>Capital</td>
<td>0.70</td>
<td>-0.27</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

Notes:

\(^a\) Total Absorption is defined as the sum of all market commodities purchased by industries, households, and government in the region. Absorbed commodities are either locally produced, imported, or supplied by government or other non-industrial sources (e.g., logs from national forests).

\(^b\) Exports and investment are exogenous variables in the fixed-price IO model.
## TABLE 3
### IMPACT OF MEASURE 5 ON HOUSEHOLD CONSUMPTION, INCOME, AND TAXES (% CHANGE)

<table>
<thead>
<tr>
<th></th>
<th>Keynesian CGE</th>
<th>Neoclassical CGE</th>
<th>Fixed-Price IO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Mid</td>
<td>High</td>
</tr>
<tr>
<td>Consumption</td>
<td>2.06</td>
<td>3.15</td>
<td>6.30</td>
</tr>
<tr>
<td>Total Income</td>
<td>0.67</td>
<td>1.95</td>
<td>2.09</td>
</tr>
<tr>
<td>After-tax Income</td>
<td>1.49</td>
<td>2.57</td>
<td>5.70</td>
</tr>
<tr>
<td>Federal Taxes</td>
<td>0.69</td>
<td>1.98</td>
<td>2.07</td>
</tr>
<tr>
<td>State-Local Taxes</td>
<td>-20.57</td>
<td>-17.72</td>
<td>-17.61</td>
</tr>
</tbody>
</table>

Notes: Definitions of household income classes ($1990) and percentages of total Oregon households (1989 Census) are as follows:

<table>
<thead>
<tr>
<th>HH Income Class</th>
<th>Income Range ($1990)</th>
<th>% of Oregon Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt; $20,000</td>
<td>35.5</td>
</tr>
<tr>
<td>Middle</td>
<td>$20,000-$39,999</td>
<td>34.9</td>
</tr>
<tr>
<td>High</td>
<td>&gt; $40,000</td>
<td>29.6</td>
</tr>
<tr>
<td>Total</td>
<td>1,105,362 Households</td>
<td>100%</td>
</tr>
</tbody>
</table>

## TABLE 4
### IMPACT OF MEASURE 5 ON GOVERNMENT TAX REVENUES AND EXPENDITURES (% CHANGE)

<table>
<thead>
<tr>
<th></th>
<th>Keynesian CGE</th>
<th>Neoclassical CGE</th>
<th>Fixed-Price IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Tax Revenues</td>
<td>2.22</td>
<td>2.40</td>
<td>-73.60</td>
</tr>
<tr>
<td>($ million)</td>
<td>220</td>
<td>102</td>
<td>-1,225</td>
</tr>
<tr>
<td>Business Taxes</td>
<td>1.09</td>
<td>2.70</td>
<td>-73.10</td>
</tr>
<tr>
<td>Household Taxes</td>
<td>1.95</td>
<td>2.14</td>
<td>-74.0</td>
</tr>
<tr>
<td>State Transfers to Schools</td>
<td></td>
<td>89.28</td>
<td>—</td>
</tr>
<tr>
<td>Expenditures on Goods, Services, and Payrolls</td>
<td>—</td>
<td>-17.22</td>
<td>—</td>
</tr>
</tbody>
</table>

Notes: Business Taxes include nonresidential property taxes plus business excise taxes (i.e., indirect business taxes); Household Taxes include residential property taxes plus personal income taxes; Total Tax includes corporate income and payroll taxes in addition to Business Taxes and Household Taxes.
TABLE 5
IMPACT OF MEASURE 5 ON VALUE ADDED AND FACTOR MARKETS (% CHANGE)

<table>
<thead>
<tr>
<th></th>
<th>Keynesian CGE</th>
<th>Neoclassical CGE</th>
<th>Fixed-Price IO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Value Added</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Baseline = $50.164 mil.)</td>
<td>1.25</td>
<td>-0.26</td>
<td>-2.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Factor Employment</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>2.57</td>
<td>---</td>
<td>-0.88</td>
</tr>
<tr>
<td>Proprietors</td>
<td>---</td>
<td>-0.84</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>---</td>
<td>-0.89</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Factor Prices</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td></td>
<td>1.04</td>
<td>---</td>
</tr>
<tr>
<td>Proprietors</td>
<td>2.66</td>
<td>1.04</td>
<td>---</td>
</tr>
<tr>
<td>Capital</td>
<td>2.56</td>
<td>1.04</td>
<td>---</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Factor Incomes</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>2.57</td>
<td>1.04</td>
<td>-0.88</td>
</tr>
<tr>
<td>Proprietors</td>
<td>2.66</td>
<td>1.04</td>
<td>-0.84</td>
</tr>
<tr>
<td>Capital</td>
<td>2.56</td>
<td>1.04</td>
<td>6.15</td>
</tr>
</tbody>
</table>

The fixed price model embodies most of the traditional regional economic assumptions.\(^6\) In contrast to the two CGE models, fixed-price model results depict significant decreases in regional output (Table 2) and factor employment (Table 5).\(^8\) However the reduction in endogenous factor incomes is offset by property tax savings so that total incomes of low, middle, and high income households increase by 0.76 percent, 0.17 percent, and 2.08 percent, respectively (Table 3). Total absorption decreases (Table 2) largely because the transfer of purchasing power from government to households increases regional leakage in the form of federal taxes and imports. Thus the increase in consumption (Table 3) is insufficient to offset the reduction in government expenditures (Table 4).

**The Impact on Household Income Levels and Inequality**

Measure 5 increases total and after-tax incomes for all three income classes under all three models. However income inequality also increases, especially with respect to after-tax

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\(^6\) Since government, savings-investment, and trade accounts are all exogenous in a fixed-price model, a different treatment of the shock scenario was required. Reduced tax collections were translated directly into reduced exogenous government demand for goods and services. Household property tax savings were rebated to households as exogenous income. Industry property tax savings were assumed to accrue to capital which is in turn mapped into institutional and household incomes.

\(^7\) It should also be noted that the import-ridden SAM differs conceptually from the more standard treatment of import-purged regional SAMs. In the import-ridden case, competitive imports by sector of origin enter a separate absorption (commodity) account as an augmentation of regional supply. Augmented regional supply is then allocated to satisfy regional demand. In the standard, import-purged case, the bill of imported commodities is not explicitly enumerated. Import purchases by sector of destination are treated in aggregate fashion simply as leakages from each expenditure account.

\(^8\) In the fixed-price model, capital income is seen to increase under the assumption that industry property tax savings accrue directly to owners of capital.
income. Under all three models, the percent change in total incomes of the high-income households is about three times as great as that of low-income households. The economic adjustments of businesses and households to the Measure 5 reduction in property taxes clearly favor high-income households.

The impact of Measure 5 on after-tax income is even more favorable to high-income households. The percent increase in after-tax incomes of high-income households is about four times that of low-income households. This implies that Measure 5 benefits high-income households disproportionately, not only from product and factor market response to Measure 5 but also from the distribution of tax burden under the new tax system.

**Impact on the Public Sector**

Measure 5 has two primary impacts on the public sector. First, by dramatically reducing school property taxes, it significantly decreases state-local school revenues, requiring replacement transfers from the General Fund. Second, it generates increases in federal income taxes paid by Oregon households.

All three models show the expected reduction in school tax revenues: -73.6 percent ($1,225 mil.) assuming Keynesian CGE, and -73.9 percent ($1,231 mil.) under both neoclassical CGE and fixed-price assumptions (Table 4).

Under Measure 5, the state is required to replace property tax reductions affecting schools with other revenues from the state general fund. Many voters believed that Measure 5 would hold school spending constant. However the measure does not require that historic school spending levels be maintained. The legislature can thus reduce other transfers to schools, thereby reducing total school spending, and still comply with Measure 5’s “replacement requirement.” Our analysis adopts the assumption that real school spending is indeed held harmless in order to examine the impact of Measure 5 on the Oregon economy if all spending cuts were absorbed by nonschool functions of state and local government.

To maintain fixed real school spending levels, transfers to schools from the state general fund must increase by 89.3 percent in the Keynesian CGE and by 90.4 percent in both the neoclassical CGE and fixed-price models (Table 4). With schools thus held harmless, nonschool expenditures decrease by 17.22 percent under Keynesian, by 18.82 percent under neoclassical, and by 19.33 percent under fixed-price assumptions (Table 4).

State and local government nonschool tax revenues increase slightly under all three model specifications, by 2.4 percent ($102 mil.) under Keynesian, by 1.09 percent ($47 mil.) under neoclassical, and by 1.23 percent ($53 mil.) under fixed-price assumptions, thus somewhat offsetting the reductions noted above. The increase is greatest under Keynesian CGE specification due to relatively greater expansion in the private sector. But by drastically reducing school property taxes, Measure 5’s major impact is on nonschool spending due to the requirement to replace school revenues. Even if schools do see some reductions in real spending, it is likely that the major cuts under Measure 5 will be in state-supplied functions such as human services and higher education.

Oregon tax payments to the federal government increase under all three specifications due to income growth and reduced deductions of state and local taxes. The increase is again greatest in the Keynesian CGE model due to the relatively greater income growth (Table 4). Any surplus of regional federal government revenues, net of fixed expenditures, is treated as a net financial outflow from the region. Since the increased federal revenues are not matched by
changes in federal spending, they represent a leakage of income from Oregon’s point of view.

**Impact on the Progressivity of the Tax System**

Measure 5 affects not just the level of revenues and spending but also the incidence of taxes, that is, who bears the burden of the taxes. The CGE model facilitates analysis of tax incidence because it captures the shifting of taxes among classes of economic agents as factor and product markets adjust.

A tax system is considered progressive if taxes increase as a share of income as incomes increase. That is, higher-income households pay a larger share of their incomes in taxes than do low-income households. For example, in Oregon, the federal tax system is highly progressive. High-income households pay 18.10 percent of their income as federal income taxes. Low- and middle-income households pay 3.14 percent and 3.29 percent, respectively (Table 6). Measure 5 had no discernible effect on these shares.

The Oregon pre-Measure 5 state and local tax system is not as progressive as the federal system. Although high-income households pay the highest share, 12.73 percent of income, as state and local taxes (Table 6), low-income households pay a slightly higher share of their income as state and local taxes than middle-income households (3.65 percent versus 2.98 percent, respectively).9

The effect of Measure 5 on the progressivity of the Oregon state-local tax system is mixed. Under Keynesian modeling assumptions, taxes as a percentage of income declined by 2.46 percentage points for high-income households, by 0.77 percentage point for low-income households, and by 0.58 percentage point for middle-income households (Table 6).10 Consequently taxes became somewhat more progressive for low-income households but less progressive at the top of the income distribution (Figure 1).

**VI. IMPLICATIONS OF ALTERNATIVE MODEL SPECIFICATIONS**

Tax reduction under Ballot Measure 5 transferred revenues from state and local governments to the federal government and households. Different model specifications predict qualitatively different responses to this transfer. Flexible-price models find a supply response in the optimal allocation of substitutable factors in terms of the relative marginal valuations of producers and consumers. Demand driven fixed-price models simply reallocate purchases and change supply in proportion to existing expenditure patterns.

The Keynesian CGE model utilizes elastic supplies of labor and finance to show the greatest regional response, including real increases in regional output, income, consumption, and more favorable government balances. The neoclassical CGE, constrained by regionally inelastic factor supplies, responds by shifting resources to produce increases in income and consumption, but almost no change in regional output.

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9 State and local taxes paid by low-income households are probably somewhat underestimated since a disproportionate share of low-income households are renters who pay property taxes indirectly as a portion of their rent. In this model, property taxes on rental housing are assumed paid by property owners.

10 These results are basically similar for all three models.
TABLE 6
IMPACT OF MEASURE 5 ON PROGRESSIVITY OF HOUSEHOLD TAXES (KEYNESIAN CGE)

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fed taxes as % of HH Income</td>
<td>3.14</td>
<td>3.29</td>
<td>18.10</td>
</tr>
<tr>
<td>S/L Taxes as % of HH Income</td>
<td>3.65</td>
<td>2.98</td>
<td>12.73</td>
</tr>
<tr>
<td>Measure 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fed Taxes as % of HH Income</td>
<td>3.14</td>
<td>3.29</td>
<td>18.10</td>
</tr>
<tr>
<td>S/L Taxes as % of HH Income</td>
<td>2.88</td>
<td>2.40</td>
<td>10.27</td>
</tr>
</tbody>
</table>

FIGURE 1
STATE AND LOCAL TAXES AS A PERCENT OF HOUSEHOLD INCOME

The fixed-price model predicts the smallest increase in household incomes and consumption, and uniformly negative changes in regional output and absorption.

The supply response in the fixed-price model stands in sharp contrast to the CGE analysis. In the absence of endogenous prices, adjustment in the fixed-price model can necessarily determine only quantities. Output, factor utilization, and commodity absorption all decline in fixed proportions in response to reduced demand. Any possibility of outward shifts in industry supply curves in response to the tax cut is ignored.
Because it fails to include price-responsive behavior of producers and consumers, the fixed-price model predicts that regional output, employment, and investment will all decline. In the CGE model these variables remain basically unchanged or increase. In finding a new equilibrium, CGE models allocate the response between output and price components. Profitable possibilities for factor and commodity substitution are fully exploited. By varying the assumed elasticity of labor supply, results ranging from virtually no change to significant employment growth were demonstrated using the CGE model variants.

VII. IMPLICATIONS FOR POLICY

A general equilibrium analysis of the impact of Oregon’s property tax limitation allows several important conclusions: (1) Household income increases under the measure. High-income households benefit most from the measure and low-income households least, so that income inequality increases with Measure 5. (2) Even as income grows, and state income taxes increase, total state and local government tax revenues and spending can be expected to shrink significantly. (3) Measure 5 makes Oregon’s tax system slightly less progressive at the top of the income distribution but slightly more progressive at the low end. (4) Under the assumption that school expenditures will not be allowed to shrink, other state and local expenditures are reduced by more than one-sixth under Measure 5, even though the state output and income increase.

Several implications follow from these conclusions. Tax-cut induced growth does not generate nearly enough tax revenue to offset the tax cut. The analysis suggests that, under the full phase-in of the limitation in 1995-96, annual state and local government revenues would, *ceteris paribus*, be reduced by $1.1 to $1.2 billion in real terms out of a total baseline state-local spending of about $12.3 billion. Most of this reduction would be expected to be taken from human services and higher education.

The idea that tax cuts induce self-financing economic growth at the national level has recently been fashionable. This idea is usually referred to as the Laffer curve and was influential in determining national tax policy during the 1980s. This analysis does not support the idea that tax cuts can induce self-financing revenue growth at the state level. However these results do indicate that the federal government can expect between $40 and $220 million in additional tax revenues. Thus the federal government would appear to be a major beneficiary of Measure 5, with the apparent irony that Oregon may be helping to balance the federal budget on the backs of state and local governments.

It should be reiterated that these results are meaningful primarily in a current accounting sense. Researching conclusions about whether Oregonians are better off under Measure 5 would require attaching monetary values to the lost public services to estimate the welfare loss resulting from public services no longer available under the Measure 5 cuts.

Even more fundamentally, however, this analysis does not consider the long-run impact of lost public services on the consumption and production decisions of Oregonians. It shows how firms and households respond to the price changes induced by the tax cut, but it does not provide insight into how households would alter their consumption bundles to replace the valued

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11 The Laffer curve argument roughly postulates that a tax cut can be self-financing (i.e., tax revenues are not reduced) if the induced economic growth increases the tax base by a greater amount, in percentage terms, than the reduction in the tax rate.
public services with substitute private services. The analysis indicates that the consumption expenditures of higher-income households, particularly, would be substantially increased, while those of low-income households would increase only modestly. Low-income households may be less able to replace lost public health and higher education services with their post-Measure 5 increases in income.

Moreover, in the long run, continuing neglect of public physical and social infrastructure and essential services could affect the ability of the private sector firms to remain profitable in Oregon. There is evidence that investments in some public services, particularly education and transportation services, have a positive impact on jobs and income (Bartik 1994; Dalenberg, Partridge, and Rickman 1995). While a general equilibrium analysis of the property tax cut indicates a stimulative impact, the longer run impact on the economy also depends on the response of firms and households to a lower public service environment. The relatively pessimistic results of the fixed-price formulation seem to reflect this concern but for the wrong reasons. In the fixed-price model, economic decline results not from any long-run deterioration of public infrastructure but from the fundamentally different nature of government and household current spending patterns. Household expenditures are subject to greater extraregional leakage in the form of import purchases and taxes. In addition, fixed-price models fail to capture factor and commodity substitution responses which are integral to modern economic theory.

APPENDIX

DESCRIPTION OF THE OREGON CGE MODEL

Data Sources and Organization

Baseline estimates of 1990 Oregon industrial output, factor demand (labor, proprietors, capital), imports, exports, consumption, government spending, and investment were generated using IMPLAN. A fortran program was used to combine IMPLAN regional reports into an import-ridden transaction matrix (Robinson, Subramanian, and Geoghegan 1993). The 528 IMPLAN industrial categories were aggregated to two sectors (“goods” and “services”) for this study. The IMPLAN distribution of consumption expenditures (in 1990 dollars) by household income category (i.e., “low” < $20,000, “middle” $20,000 - 40,000, “high” > $40,000) was maintained. The mapping from gross factor incomes into household incomes and factor taxes was made using proportions from the 1982 IMPLAN SAM for Oregon. Total government transfer payments to individuals were estimated from BEA data (USDC/BEA 1993) and distributed to households using proportions from the 1982 IMPLAN SAM.

Since the model was designed for fiscal policy analysis, particular attention was paid to accurately representing regional state and local school, nonschool, and federal government accounts. IMPLAN estimates of regional expenditures by the federal government were adjusted using independent data (ACIR 1992). Aggregate expenditures and revenues of school and nonschool functions of state and local government were estimated using data from published sources (USDC/Bureau of the Census 1991, 1993). Aggregate payments of federal and state income tax, and local school and nonschool property taxes were allocated across the household income distribution based on state revenue estimates (State of Oregon, Legislative Revenue Office 1993; State of Oregon, Oregon Department of Revenue 1993). IMPLAN estimates of industry indirect
business tax payments (i.e., sales, excise, and property taxes) to federal and state and local
governments were adjusted using Oregon Department of Revenue property tax estimates to

The data were structured in a SAM format with row and column entries corresponding to
revenues and expenditures, respectively, of regional economic accounts. In a SAM, row and
column totals for a given economic account must balance. The SAM row and column structure
suggests a system of equations which can be solved for endogenous variables given a set of
exogenous variables and parameters. A CGE is distinguished from a linear SAM model by more
general specifications of production, consumption, absorption, and transformation constraints;
and the inclusion of prices which reflect the economic scarcity of all commodities and factors in
the model. Compared with fixed-price models, CGE methodology allows greater flexibility in
the specification of the optimizing behavior of firms and households in the region. The computer
program used to calibrate and solve the Oregon CGE model was adapted from GAMS code
originally written by David Kraybill and Dee-Yu Pai (Kraybill and Pai 1993).

Structure of the CGE

Appendix Figure 1 traces the linkages between components of the CGE. First, value is
added to inputs of labor, proprietors’ services, and capital via linearly homogeneous Cobb-
Douglas production functions and combined with intermediate inputs to produce output (X) for
each sector. Each unit of X is either sold regionally (XXD) or exported (E) via a constant
elasticity transformation function (CET). Exports supply world markets, facing perfectly elastic
demand conditions (i.e., fixed world commodity prices).

Regionally produced goods (XXD) are absorbed along with competitive imports (M) via
a constant elasticity of substitution (CES) Armington function, forming a “composite” absorption
good for each commodity (Q). This composite mix of imports and regional goods supplies final
demand for consumer goods (C), investment goods (IT), and government purchases (G).

Federal government expenditures and regional government spending on schools are
assumed exogenous, while regional nonschool spending is determined in the model by
dependent tax revenues. Likewise, changes in household spending are driven by endogenous
factor incomes. Investment is either endogenous or exogenous depending upon model closure.

Production

There are two very broadly aggregated producer sectors, “goods,” and “services.” Output
in each sector is determined by a linearly homogeneous Cobb-Douglas production function using
inputs of labor, proprietors’ services, and capital. First-order conditions for profit maximization
(with endogenous output prices) determine input demand for each sector. Depending on closure,
average factor return rates or total factor supplies adjust until derived demand equals supply for
each factor. In addition, commodities are allocated between sources and destinations within and
outside the region via two types of constant elasticity aggregation functions. This feature
accommodates the phenomenon of crosshauling in which simultaneous imports and exports are
observed in highly aggregated sectors (Shoven and Whalley 1984, 1992).

Each sector’s output is allocated between export and regional sales via a constant
elasticity transformation (CET) function. In effect each sector is modeled as a two-product firm,
producing one product for export and another for the local market. First-order conditions for
sales revenue maximization determine the relative proportion of exports to local supply for each sector. The magnitude of the transformation elasticity determines the relative ease with which production can be switched to satisfy regional versus export demand. In the case of relatively undifferentiated or highly aggregated commodities, we would expect this transformation to appear relatively easy. A small variation in relative prices would tend to induce a proportionately large supply shift. In the case of relatively specialized products as well as most services, we would expect a more difficult transition and a correspondingly less elastic response to a change in the price ratio.

APPENDIX FIGURE 1
Schematic of Oregon 1990 CGE Model
A constant elasticity of substitution (CES) “Armington function” combines regional supply with an imported counterpart to form a composite absorption commodity. Each sector’s composite represents total supply of that commodity available to satisfy regional demand. First-order conditions for expenditure minimization determine the relative demand proportion of imports to local supply for each commodity. The magnitude of the elasticity of substitution determines the relative ease with which demand can be satisfied from regional versus imported sources. In the case of relatively undifferentiated or highly aggregated commodity classifications, we would expect this substitution to occur fairly readily. A small variation in relative prices would tend to induce a proportionately large demand shift. In the case of relatively specialized commodities and most services, we would expect substitution to be correspondingly less responsive to a change in the price ratio between imported and local supply.

Given fixed import and export prices, expenditure functions (duals of the CES functions) and revenue functions (duals of the CET functions) determine endogenous prices for each sectors’ total output, total absorption, and regional production. Value added per unit of output is calculated by subtracting indirect taxes and payments for intermediate inputs from each sector’s average regional producer price. A general equilibrium model embodies Walras’s Law, hence all prices are relative to a designated numeraire. In the Oregon model the exchange rate, defined as the value of the regional unit of exchange in terms of world prices, is set equal to one.

**Household Income**

Income is allocated to factors (labor, proprietors, and capital) based on equilibrium input quantities and factor prices. Factor incomes are mapped into institutional incomes (labor, proprietors, capital, and enterprises) net of payroll taxes, capital taxes, depreciation, enterprise savings, and factor residence adjustments. Institutional income and public and private transfer income are mapped into three household income categories (low, middle, and high) according to fixed institutional shares.

**Government Revenue**

Government revenue is collected via payroll and capital taxes assessed on factors; property and excise taxes collected from producers; income and property taxes collected from households; and commodity sales by government agencies. Oregon has no general sales tax. Other regional government revenues (federal grants, investment income, net interest, lottery revenues, and other taxes) are treated as fixed, exogenous inflows to the state and local government accounts.

**Consumer Expenditure**

Consumer expenditure is modeled as a function of commodity prices and fixed shares of household disposable income according to a linear expenditure system (LES). In the absence of minimum household subsistence expenditures, the LES reduces to a Cobb-Douglas expenditure function. Consequently there are no cross price or income effects and all goods are substitutes in consumption.
Government Expenditure

Federal government and regional school-related expenditures are fixed in real terms. Commodity purchases by the regional nonschool sector are determined residually as shares of total revenue net of transfers to regional schools and households. Any exogenous decrease in school revenues must be accommodated by a transfer from the state general fund.

Macro Closure

The six major macro balances in the model are Savings = Investment; the three government account balances (federal, state, and local nonschool, and state and local schools); the balance of trade (exports minus imports); and payments = receipts in the external financial account. Each is briefly described below.

The supply of savings includes household savings (fixed proportions of disposable income), and a net financial inflow from outside the state. Rather than being considered as direct contributions to the regional savings supply, depreciation and retained earnings are treated here as payments to the external financial account. This specification should be more consistent with the operation of capital markets in small regions. Under neoclassical closure, investment adjusts endogenously to balance combined fixed external savings and income-driven household savings. Under Keynesian closure, investment is fixed and net financial flows adjust to equate regional savings with investment demand.

The regional federal government deficit is determined residually as the difference between federal government revenues and expenditures in the region. In the base year, there was a net surplus on the regional federal government account. In the regional school account, fixed expenditures are financed by fixed federal grants, endogenous tax revenues, and endogenous transfers from the state general fund. Commodity expenditures by the regional nonschool account are determined residually after financial obligations to households and schools have been met. In the regional trade account, the exchange rate is fixed. An endogenous financial flow variable offsets net imports to maintain regional trade balance.

Receipts to the external financial account include depreciation and retained earnings from the factor accounts, the trade balancing financial flow from the current account and the federal government “surplus.” Expenditures by the financial account include net payments of dividends, interest, and rent to the enterprise account; any private transfers to households; “other” state and local government revenues; and a financial inflow to accommodate investment needs. Since the model satisfies Walras’s law, one of these six conditions is redundant given the other five. Consequently the equilibrium condition for the external financial account has been dropped from the model.

Calibration of Model Parameters

Calibration is a procedure whereby model parameters are determined from baseline (i.e., equilibrium) SAM data. To calibrate the model, all prices are set equal to unity and the base year factor levels and SAM flows are substituted into the model as equilibrium values of model variables. The equations are then solved in reverse for the underlying parameterization (e.g., input-output coefficients, shift and share parameters for Cobb-Douglas, CES and CET functions,
average tax rates, etc.). In this respect, calibration is like parameter estimation using the maximum likelihood technique with only a single degree of freedom (i.e., deterministic).

The CES Armington functions model imperfect absorption substitutability between imports and regional goods. CET functions approximate imperfect transformability between products for export and regional markets. These specifications serve to partially insulate the regional price system from exogenous changes in world commodity prices. The degree of insulation is determined by the CES substitution and CET transformation elasticities. Elasticity estimates for CES and CET functions were selected based on values used in other studies (de Melo and Tarr 1992). A relatively elastic value of 1.5 was used for the more readily traded aggregate “goods” commodity. A relatively inelastic estimate of 0.4 was used for “services.”

To check the parameterization, all quantity variables and prices are assumed endogenous and the model is solved in GAMS using nonlinear programming to maximize household consumption. If the CGE has been properly calibrated, this solution will exactly reproduce the base year factor levels and SAM flows.

Model Closure

The proliferation of CGE modeling has given rise to another issue. That is, given the tremendous flexibility of possible mathematical specifications for CGEs, what are appropriate specifications for “closure” of regional models (Rickman 1992; Harrigan and McGregor 1989)? In economic modeling, closure refers to the specification of accounting and behavioral relationships between economic variables which determine how a model adjusts to economic shocks (Kraybill 1993). In a Walrasian system, there are more equations determining the relationships between variables than there are free variables to be determined (Rattso 1982). Different closures represent alternative theoretical treatments of this basic over-determination of the Walrasian system. Generally, one of the redundant conditions is dropped.

To illustrate the issue of closure, consider an economy in equilibrium. A necessary condition must be that:

\[ Y \equiv E \]  
where \( Y \) is total income and \( E \) is total expenditure. In a closed economy without government, this implies that:

\[ Y \equiv C + I \]  
\[ Y - C \equiv I \]  
\[ S \equiv I \]

where \( C \) is consumption, \( I \) is investment, and \( S \) is savings. In a closed economy, total income and total expenditures are in equilibrium when savings is equal to investment demand.

In an open economy with government, a more general specification is:

\[ Y = C + I + G + (E - M) \]
where $Y$, $C$, and $I$ are as before; $G$ is government spending; $E$ is exports; $M$ is imports; $c$, $s$, and $t$ are proportions of income allocated to consumption, savings, and taxes, respectively ($c+s+t=1$); $F$ is a net inflow of savings; $D$ is the net government balance; and $B$ is net regional exports. Equation [8] states that income and expenditures are in equilibrium when net imports are balanced by net inflows of external private savings and government funds. Since knowing any two of these variables automatically determines the third, they are not independent. Consequently, the condition determining any one of the quantities $B$, $F$, or $D$ can be dropped.

Although there is no standard terminology, CGE closures can be classified under three primary categories: neoclassical, Keynesian, or Johansen (Kraybill 1993). Under neoclassical closure, endogenous factor prices adjust until factor supplies are fully utilized. Factor incomes determine regional savings which combine with fixed financial inflows to determine endogenous investment. Keynesian closure assumes that, due to fixed or “sticky” factor prices, labor supplies may not be fully utilized. Endogenous employment and external financial inflows adjust so that aggregate savings is just adequate to meet exogenous investment requirements. Under Johansen closure, consumption adjusts residually until savings and investment requirements are balanced given fixed factor supplies.

Unfortunately, the mechanisms which determine regional financial flows and their effect on other macro variables are not well understood (Dow 1986). With a fixed exchange rate, the regional counterpart of a current account deficit has uncertain significance. In the absence of well-developed theory on the regional balance of payments issue, Kraybill (1993) has suggested that a Keynesian specification, with elastic supplies of some factors and endogenous financial flows, may be the more practical specification for modeling regional economies. Rickman (1992), on the other hand, suggests that results under his neoclassical closure seem to better fit available empirical evidence of regional economic adjustment.

References


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