Pyramiding, Productive Efficiency, and Revenue under a Gross Receipts Tax

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Abstract

Although gross receipts taxes (GRTs) have been a major source of revenue for states since before the Great Depression, the scholarly literature has come to view them as highly inefficient because they distort consumer and producer behavior in multiple ways. And yet, recent years have seen a number of states implementing new gross receipts taxes. However quantitative analysis of GRTs, either to prove or disprove their inefficiency, is very limited. The comparisons between GRTs and any other business tax is further complicated because the actual burden imposed by a GRT is hidden by tax pyramiding – multiple levels of taxation at various stages of the production process in addition to the taxation of final sales to consumers. To resolve these problems, we construct a general equilibrium model of a state economy and use it to view the effects of replacing a retail sales tax with a GRT. The major findings are: (1) a retail sales tax would need a statutory rate of 1.78 percent in order to be revenue neutral with a 1 percent GRT; (2) the GRT raises average prices by 0.5 percent;(3) the GRT reduces average demand by 1.3 percent; (4) failing to account for consumer and producer substitution would overstate the expected revenue of the GRT by 3.5 to 4.5 percent; and, (5) the excess burden of the GRT is 19 percent of revenue while it would only be 13 percent of revenues for the sales tax. However there is substantial variation by industry with the largest price increases for industries that use large amounts of intermediate inputs. But the drop in demand is not as concentrated in firms that use large amounts of intermediate goods as the price increase is. Taken together, these results indicate that the burden of a GRT varies widely across sectors and that a GRT is substantially less efficient than a sales tax on final goods.

I. Introduction

A gross receipts tax is a tax levied on the gross receipts (total revenue) of a firm, or equivalently, a tax on all of a firm's sales to other firms (intermediate goods) and also to consumers (final goods). This differs from a retail sales tax which, in principle, is applied only on sales to consumers. The consequence of intermediate good taxation is tax pyramiding, the process by which a good is taxed multiple times as it is sold from firm to firm through the production process before finally being sold to a consumer and taxed again. Previous literature has identified the types of inefficiencies caused by tax pyramiding but has not quantitatively estimated how significant this inefficiency is in a gross receipts tax.

In this study, we utilize a general equilibrium model that allows for substitution between inputs by both consumers and producers to estimate how much the price of goods will rise and demand will fall due to the imposition of a GRT. Additionally, we estimate the sales tax rate required to yield the same revenue as a GRT and how ignoring the ability of consumers and producers to substitute away from highly taxed goods biases revenue estimates. Finally we calculate the excess burden of a GRT and that of a revenue neutral sales tax.[1] To our knowledge, this is the

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[1] In economics, the excess burden of a tax is a loss of economic efficiency that can occur when the tax causes firms and consumers to change their behavior to activities they found less desirable before the tax, simply because it lowers their tax payment. It is a cost of the tax to business firms and consumers that is

first paper to estimate the price effects of a GRT with a cost function that allows for the substitution between inputs, and the first to estimate by any means a GRT's revenue equivalency, demand effects, excess burden, or sensitivity of revenue estimates.

This paper is organized as follows. Section II surveys features of gross receipts taxes and their use in US states.[2] Special emphasis is placed on the relative advantages of GRTs and sales taxes compared to each other. Section III briefly summarizes the methodology used in the model and the assumptions used to calculate price changes from the production function. Section IV describes the results in detail. Section V summarizes the paper and concludes.

II. Background

The history of gross receipts taxes stretches back to the 13th century when the first gross receipts taxes were implemented in medieval Europe. And like today, they were historically a subject of scholarly criticism. For example, in the 18th century Adam Smith commented unfavorably on the Spanish gross receipts tax and suggested that the country's lack of development compared to Great Britain was due to the tax's high administrative burden.[3] However, gross receipts taxes did not become fiscally important to US states until just before the Great Depression.

And although the end of the 20th century saw a decline in their use in Europe, a number of states have experimented with GRTs in the last decade, as shown in Figure 1. During that time period, broad base GRTs existed in at least 18 states, and 4 of those were newly implemented GRTs.[4, 5, 6] Despite a number of attractive features that have motivated the adoption of GRTs in recent years, the general academic consensus is that they are undesirable due to pyramiding and its consequences.[7] But advocates of GRTs stress the size of their base and their revenue stability.

A GRT does indeed have the capacity to have an extremely broad base. If the GRT does not distinguish among businesses on organizational form or have special provisions to reduce pyramiding, then the basis of the tax is as broad as the revenue of all businesses in the state. For economists, a broad tax base is usually desirable in order to ensure that it includes all goods, to

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over and above the actual tax payments to the government. We measure average excess burden as the equivalent variation that consumers would be willing to pay in order to avoid the price increase brought on by the tax divided by actual tax revenues.

[2] For a survey of the literature on retail sales taxes, see Fox, W. F., & Luna, L. A. (2006). How Broad Should State Sales Tax Bases Be? A Review of the Empirical Literature. *State Tax Notes*, *41*, 639. See also McLure, C. E. (2000). Rethinking State and Local Reliance on the Retail Sales Tax: Should We Fix the Sales Tax or Discard It? *Brigham Young University Law Review*, *77*(107), 77–137.

[3] Smith, A. (1937). *The Wealth of Nations*. New York: Modern Library, p. 850.

[4] Mikesell, J. L. (2007). Gross Receipts Taxes in State Government Finances: A Review of Their History and Performance. *Tax Foundation Background Paper*, *No. 53*. Retrieved from http://www.taxfoundation.org/files/bp53.pdf

[5] Pogue, T. F. (2007). The Gross Receipts Tax: A New Approach to Business Taxation? *National Tax Journal*, *60*(No. 4), 799–879.

[6] Mikesell actually defines many of these taxes as retail sales taxes, despite their statutory incidence, because of other features they have.

[7] For a more detailed examination of the problems of GRTs see Testa, W., & Mattoon, R. H. (2007). Is There a Role for Gross Receipts Taxation? *National Tax Journal*, *60*(No. 4), 821–840.

limit the possibility for consumers to substitute away from the tax. But as we shall see, the base of a GRT is likely to be too broad, as the application of the tax to every transaction results in the taxation of intermediate goods and thus inefficient tax pyramiding.

Also because of the size of the base, a large amount of revenue can be raised even if the statutory rate is very low. For policy makers a low statutory rate can make the tax more palatable. But for economists the statutory rate is relevant only in so much as it determines the effective tax rate, and a GRT will have an effective rate higher than the statutory rate. The disconnect between the statutory rate and the effective rate is related to the problem GRTs have with transparency that is discussed later.

In addition, a GRT is likely to be a stable source of income since a firm's total revenue fluctuates much less than firm profits. Mikesell reviews state government finances, including GRTs, and finds that revenue of a statewide GRT is about as stable as a retail sales tax and is much more stable than a corporate income tax.[8]

Previous academic literature has been overwhelmingly negative in its assessment of GRTs, primarily due to intermediate good taxation and its consequence, tax pyramiding. An intermediate good making its way through a supply chain will be sold multiple times. Since businesses are taxed on total revenue, each time the good is sold it is counted in the revenue of the selling firm and thus subject to gross receipts taxation. This repeated taxation of a good is referred to as tax pyramiding. Previous literature has identified three main problems with tax pyramiding: arbitrary rates, productive inefficiency, and transparency.

The first problem is that the effective tax rates faced by each industry due to the gross receipts tax are not equal to the statutory rate. Because of pyramiding, the amount of tax included in the final price of the good depends not only on the statutory rate but also the number of transactions involved in its production and how early in the supply chain value added is imparted into the good. If the industry is structured so a good passes through a large number of firms before reaching consumers or if value added is created very early in the production process, the GRT will impose a larger tax on the final good than if it was produced by fewer firms or has more of its value added later in the production process. While externalities and differences in demand elasticities may justify imposing different tax rates on different goods, a GRT applies such differentials arbitrarily, leading to inefficient variation in tax rates.

But even if we assumed these arbitrarily chosen tax rates for various industries created by the GRT were optimal, a GRT achieves these rates in manner that causes productive inefficiency. Diamond and Mirrlees showed that in an optimal tax structure for a competitive industry, there are no taxes on intermediate goods.[9] Their intuitive explanation is that the taxation of intermediate goods causes firms to inefficiently substitute away from more heavily taxed inputs.[10] And the burden of the tax is passed on to the final good market anyway through changes

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[8] Mikesell, *op. cit.*

[9] Diamond, P. A., & Mirrlees, J. A. (1971). Optimal Taxation and Public Production I: Production Efficiency. *The American Economic Review*, *61*(1), 8–27.

[10] This substitution is socially inefficient because as firms substitute lightly taxed goods for heavily taxed goods, they use a mix of inputs with a higher pre-tax cost but lower post-tax cost. That is, the inputs they

in the prices of the intermediate goods used to make the final goods. Since it is passed on, the revenue collected from intermediate good taxation could have instead been collected through an equivalent tax on final goods without changing final good prices. But a tax on final goods only would not have caused productive inefficiency since it would not create incentives for firms to inefficiently substitute away from highly taxed intermediate inputs.

In addition, pyramiding diminishes the transparency of the GRT because it is not obvious how much the tax has increased the price of a good above the statutory rate. Firms cannot tell how much their costs will increase since the effect of the tax on the firm is not just the amount of new taxes it pays but the higher intermediate good prices it faces from earlier pyramiding of the tax. For the same reason, consumers will not know how much the prices of goods will increase. Without this information, taxpayers cannot make informed decisions about the tradeoff between the provision of government services and the taxes levied to pay for those services. Some consumers may not even see any connection between a tax on firm gross receipts and increases in price. A cynical interpretation would argue that this as an advantage of GRTs from the viewpoint of policymakers as it reduces the opposition to taxation.

Most of the previous literature on GRTs, such as the papers by Mikesell and Pogue, has been qualitative and descriptive. [11, 12] But two previous papers have quantitatively examined the degree of pyramiding under specific state GRTs. Del Valle analyzed New Mexico's GRT by comparing the revenue of a hypothetical GRT with no pyramiding relief to the current law GRT's revenue.[13] They use a fixed coefficient input-output model to calculate the total dollar amount each sector spends on business inputs. They then apply the GRT rate and deduct from this amount the total inputs that are not taxed by the GRT in order to calculate the maximum possible pyramiding and the actual pyramiding under current law. They find pyramiding increases the effective tax rate an average of 1.35 percentage points on top of the 5 percent statutory rate, a 27 percent increase.

Washington State Tax Structure Committee performs a similar study for Washington.[14] They use a fixed coefficient input-output model to estimate the increase in final good prices due to the pyramiding of the Washington GRT. They find pyramiding results in an effective tax rate on value added that is on average 0.9 percentage points higher than the average statutory rate of 0.6 percent, a 150 percent increase. Since the New Mexico GTR is much older than the Washington GTR, Pogue postulates that its lower level of pyramiding may reflect an evolution of tax law over time as the firms that face the worst pyramiding petition policymakers for relief.[15]

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are now using are less effective at producing output. This difference in costs is a socially inefficient deadweight loss.

[11] Mikesell, *op. cit.*

[12] Pogue, *op. cit.*

[13] del Valle, M. (2005, September). A Report on the Gross Receipts Tax. New Mexico Tax Research Institute. Retrieved from http://www.nmtri.org/associations/3740/files/Pyramiding%20Report-Final2.pdf

[14] Washington State Tax Structure Committee. (2002). *Tax Alternatives for Washington State: A Report to the Legislature*. Olympia, Washington.

[15] Pogue, *op. cit.*

However, taxing intermediate goods and thus pyramiding is not unique to GRTs. Ring estimates that only 59 percent of the statutory incidence of state sales taxes falls on resident consumers, with the remaining 41 percent falling on all other sources, mainly business purchases but also government and nonprofit purchases.[16] Cline et al. estimates that 43 percent of the statutory incidence falls on business purchases.[17] If roughly 40 percent of the typical sales tax base is business purchases, then these sales taxes will suffer from many of the same problems as a GRT, although a sales tax that only applied to final goods would not.

III. Methodology

In this section, we briefly describe the construction of the model we will use to determine the severity of the aforementioned problems with gross receipts taxes. We begin by estimating cost functions for each industry and an expenditure function for consumers. We then insert the cost and expenditure functions into a simple general equilibrium model of a representative state. Finally, we look at the model under a retail sales tax and compare the prices, sales, and excess burden that would result if the same amount of revenue was raised using a gross receipts tax instead. Our general methodology is a simplified version of the model used by Jorgenson, Slesnick, and Wilcoxen.[18, 19]

The data used in the regressions and simulation comes from several sources. The first is a system of U.S. national accounts covering the years 1960 to 2005 compiled by Jorgenson.[20] The data includes the quantity and price of output produced by all industries and all inputs purchased by all industries. This data is converted to NAICS basis using the 1997 Economic Census's Bridge between NAICS and SIC. Additional data comes from the BEA Tables of the Use of Commodities by Industries from 1997-2010 and the BEA Gross Output Price Index from 1987-2010.

The cost function for any industry is a mathematical expression that relates the price of the output of each industry to the cost of the inputs – labor, capital, and all the outputs produced by each industry. Although the functional form of the translog cost function is quite complex, its key features can be described simply: it allows varying degrees of substitution between all inputs, change in the relative importance of particular inputs over time due to technological progress, and change in overall productivity due to technological progress.[21] The cost function is exactly the same whether a particular unit produced by an industry is used by consumers or as an

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[16] Ring, R. (1999). Consumers' Share and Producers' Share of the General Sales Tax. *National Tax Journal*, *52*(1), 79–90.

[17] Cline, R., Mikesell, J. L., Neubig, T., Phillips, A., Ernst & Young LLP, & Council on State Taxation. (2005). Sales Taxation of Business Inputs: Existing Tax Distortions and the Consequences of Extending the Sales Tax to Business Services. *State Tax Notes*, *35*, 457.

[18] Jorgenson, D., & Slesnick, D. T. (2008). Consumption and labor supply. *Journal of Econometrics*, *147*(2), 326–335.

[19] Wilcoxen, P. (1988). The Effects of Environmental Regulation and Energy Prices on U.S. Economic Performance (Ph.D. Dissertation). Harvard University, Cambridge, MA.

[20] Jorgenson, D. W. (2007). 35 Sector KLEM. Retrieved September 12, 2011, from http://hdl.handle.net/1902.1/10684

[21] The cost function is explained in more detail in the appendix.

intermediate good by another industry. However, the cost function varies across industries. In order to simplify the model, we assume these industries are perfectly competitive with constant returns to scale. These two assumptions ensure that the price and post-tax cost of the output for each industry are identical. To get the post-tax (final) price, we multiply the pre-tax cost by the tax rate. With each industry's cost function, we can now calculate how much a GRT will pyramid and thus the effect on prices of imposing a 1% gross receipts tax. [22]

IV. Results

We find that in order to raise as much revenue as the 1 percent GRT, a retail sales tax would need to be levied at a 1.78 percent rate. However, despite having a higher statutory rate, post-tax prices would in fact be lower under the retail sales tax. The actual post-tax price increase due to the gross receipts tax compared to post-tax prices under a revenue neutral sales tax is show in Figure 2. On average, prices increase by 0.5 percent. There is substantial variation by industry with, for example, a 0.02 percent increase for finance and insurance and a 1.0 percent increase for construction. Further investigation shows that industries with heavy use of intermediate goods face the largest price increase while the price increase is smallest for industries with the least intermediate good usage. Figure 3 plots the price increase of each industry versus the fraction of that industry's costs spent on intermediate goods. Industries such as construction, transportation, manufacturing, and agriculture have high use of the intermediate goods and the highest price increase. Conversely, management and finance and insurance have low usage and low price increases. The correlation coefficient between the two is quite high at 0.85.

The changes in domestic and export demand for each good are shown in Figure 4. On average, demand falls by 1.3 percent. This decrease is smallest for real estate rental and leasing at 0.1 percent. Agriculture has the largest decrease at 2.6 percent. However, unlike for price, there is no simple explanation for why some industries have large demand decreases and others have small decreases. The result is a combination of the effects of the price increase for the industry, the elasticity of demand for the industry, and the price increase of substitutes and compliments for that industry's output.

Table 1 shows how estimates for the revenue of the 1 percent GRT change under the different assumptions. The baseline specification to which the others are compared is the version of the model described in the methodology section and assumes that producers and consumers can substitute in response to the tax and that the total quantity of labor supplied to the economy is fixed. We compare it to other specifications where stronger assumptions are made on behavior. In specification 1, instead of setting the quantity of labor in the economy constant, the price of labor is set constant and firms are allowed to hire as many workers as they want at the pre-tax price wage rate. Changing this assumption does not affect the revenue estimate. In specification 2, consumers are also not allowed to substitute in response to the tax change. This increases the revenue estimate by 3.5 percent. In specification 3, producers are also not allowed to substitute in response to the tax change, equivalent to using a fixed coefficient input-output table instead of a translog production function. In this specification, revenue is estimated to be 4.5 percent higher than in the baseline. This indicates that models attempting to estimate the revenue to be gained

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[22] Note that GRT rates are typically expressed as tax-inclusive while this definition is tax-exclusive. That means this 1% tax-exclusive GRT would actually be a 0.9900990099… tax-inclusive GRT.

from a gross receipts tax will over-estimate the revenue of the tax by 3.5 to 4.5 percent if the model does not allow consumer or producer substitution.

Finally, we calculate the average excess burden of the tax. For the 1 percent GRT, the excess burden is 19 percent of revenues. For the sales tax, it is 13 percent of revenues. Switching to a GRT from a sales tax would thus increase the excess burden of taxation by 6 percent of revenues.

V. Conclusions

Scholars have identified a number of major problems with gross receipts taxation and concluded that it is an economically inefficient tax. However, the quantitative analysis to confirm this conclusion has been extremely limited. In order to test this hypothesis quantitatively, we construct a general equilibrium model of a representative state economy and use it to assess the efficiency of a gross receipts tax. With his model, we confirm the literature's supposition that a gross receipts tax is inefficient compared to a retail sales tax. The excess burden of taxation is 6 percent higher, prices are on average 0.5 percent higher, and demand 1.6 percent lower. In addition, there is great variation by sector in the incidence of the tax, which tends to fall more heavily on industries that use a large amount of intermediate goods.

Appendix A: Figures and Tables

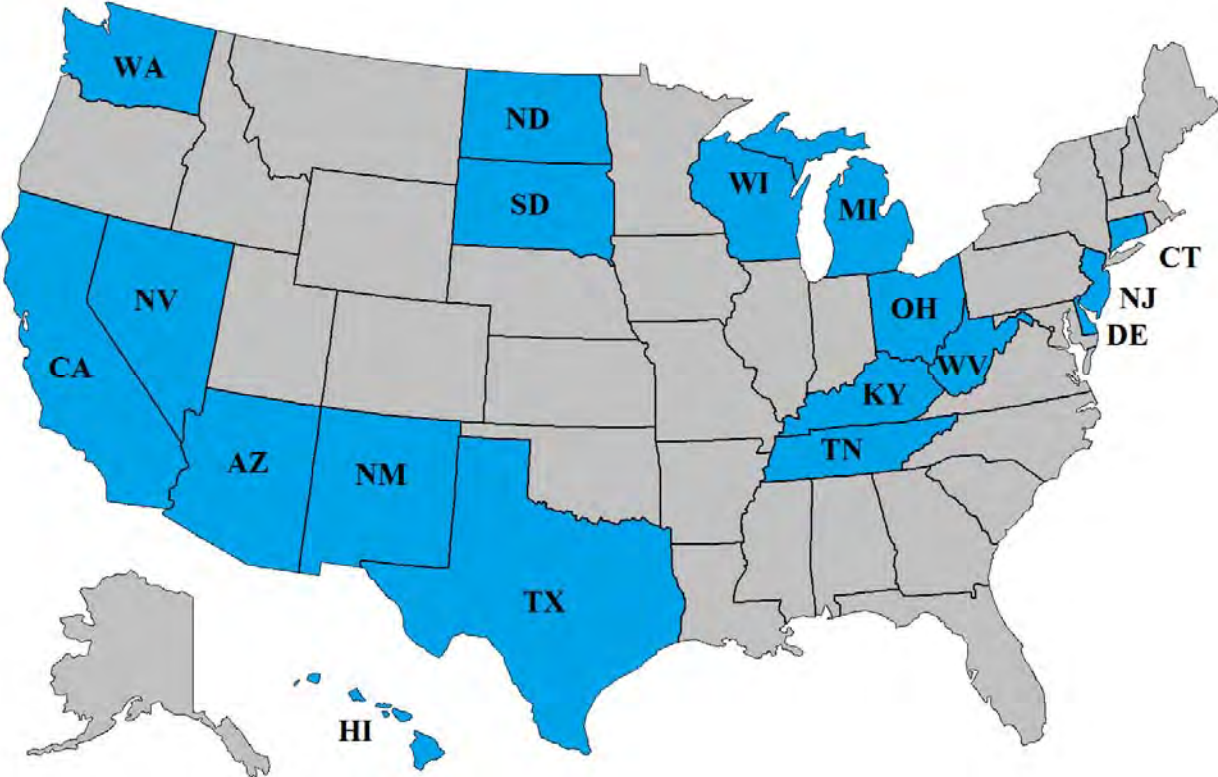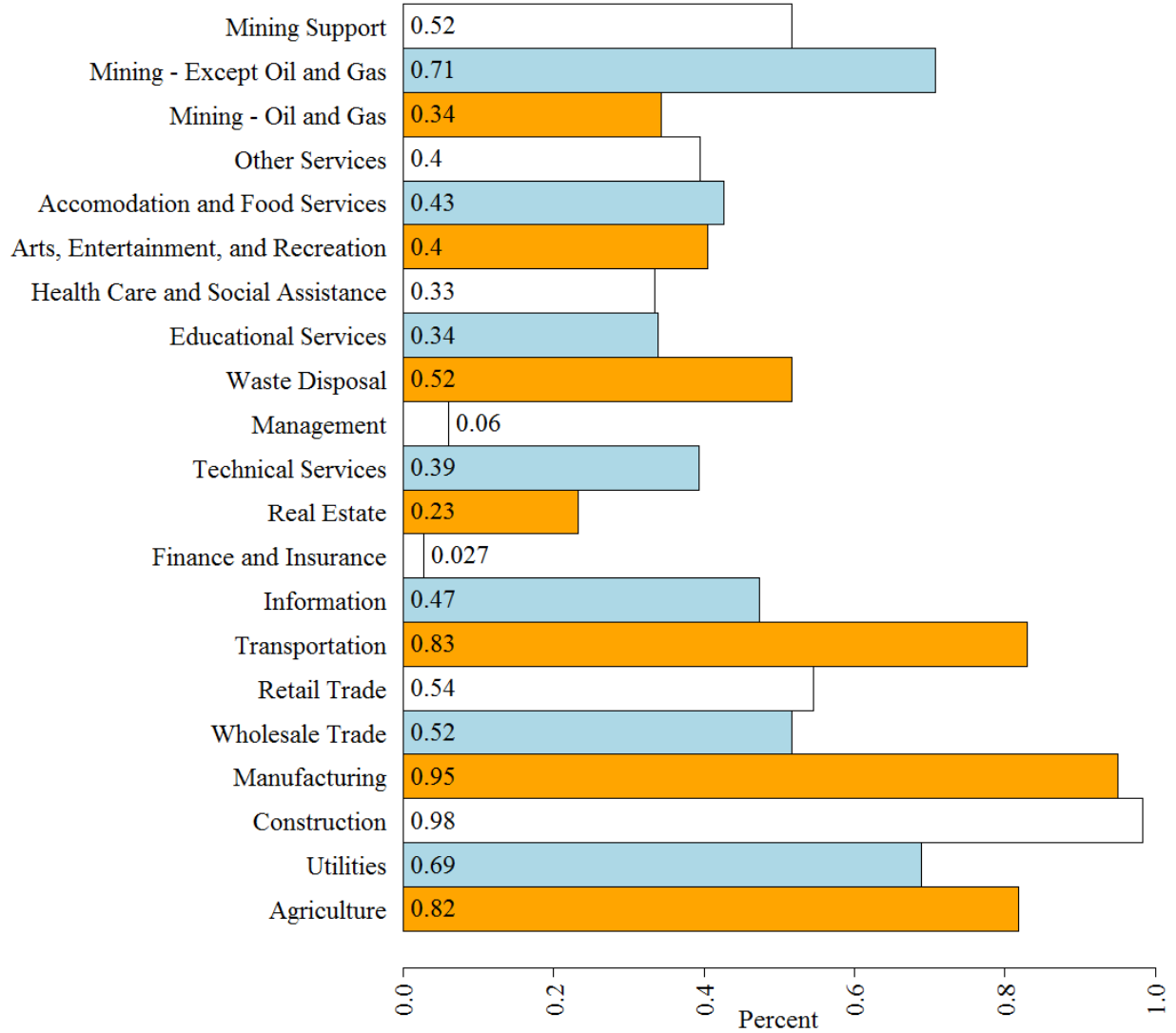Figure 1: States with statutory gross receipts taxes in 2002-2007

Figure 2: Increase in prices due to GRT, by sector

Sector	Percent
Mining Support	0.52
Mining - Except Oil and Gas	0.71
Mining - Oil and Gas	0.34
Other Services	0.4
Accomodation and Food Services	0.43
Arts, Entertainment, and Recreation	0.4
Health Care and Social Assistance	0.33
Educational Services	0.34
Waste Disposal	0.52
Management	0.06
Technical Services	0.39
Real Estate	0.23
Finance and Insurance	0.027
Information	0.47
Transportation	0.83
Retail Trade	0.54
Wholesale Trade	0.52
Manufacturing	0.95
Construction	0.98
Utilities	0.69
Agriculture	0.82

Notes: Price increase is equal to percent increase in post-tax prices caused by replacing a retail sales tax with a gross receipts tax.

Figure 3: Increase in prices due to GRT and intermediate input usage, by sector
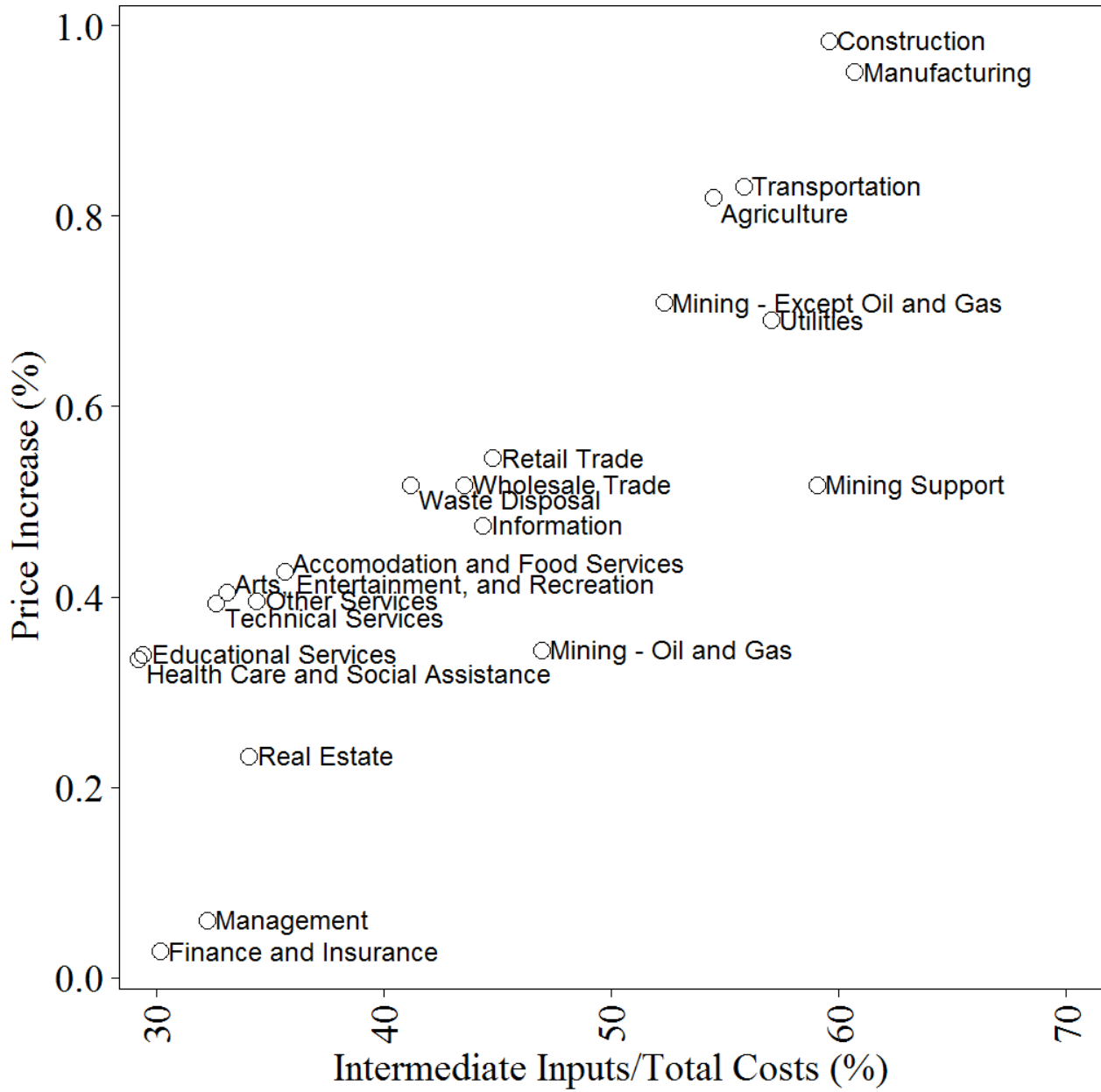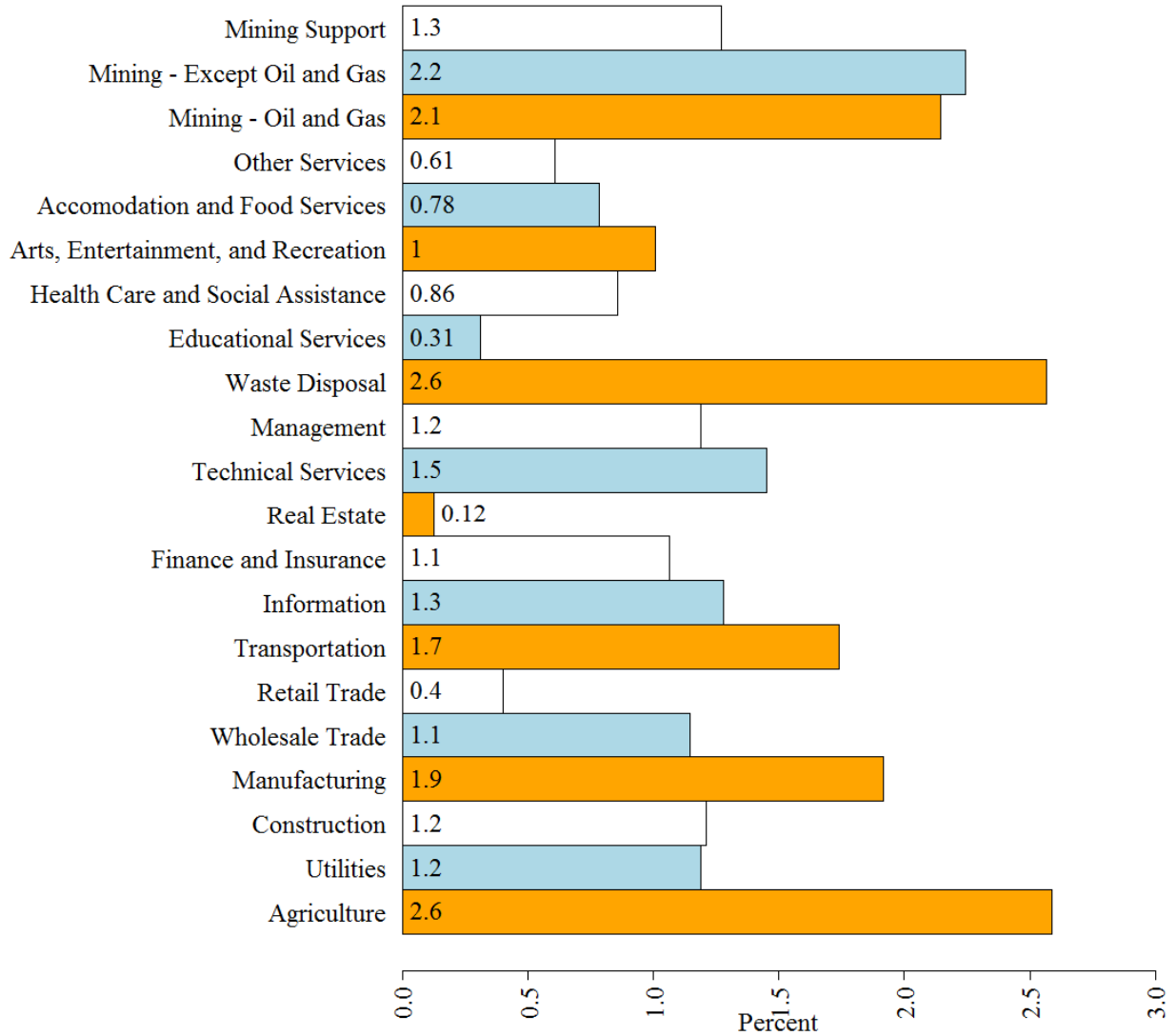

Notes: Price increase is equal to percent increase in post-tax prices caused by replacing a retail sales tax with a gross receipts tax.

Figure 4: Decrease in demand due to GRT, by sector

Sector	Percent
Mining Support	1.3
Mining - Except Oil and Gas	2.2
Mining - Oil and Gas	2.1
Other Services	0.61
Accomodation and Food Services	0.78
Arts, Entertainment, and Recreation	1
Health Care and Social Assistance	0.86
Educational Services	0.31
Waste Disposal	2.6
Management	1.2
Technical Services	1.5
Real Estate	0.12
Finance and Insurance	1.1
Information	1.3
Transportation	1.7
Retail Trade	0.4
Wholesale Trade	1.1
Manufacturing	1.9
Construction	1.2
Utilities	1.2
Agriculture	2.6

Notes: Demand decrease is equal to percent decrease in domestic and export demand caused by replacing a retail sales tax with a gross receipts tax.

Table 1: Sensitivity of revenue estimates

Specification	Baseline	1	2	3
Producer Substitution	Yes	Yes	Yes	No
Consumer Substitution	Yes	Yes	No	No
Price of Labor Constant	No	Yes	Yes	Yes
Quantity of Labor Constant	Yes	No	No	No
Revenue Change (%)	0	0	3.5	4.5

Notes: Revenue change is equal to percent increase in GRT tax revenue compared to the GRT tax revenue of the baseline specification.

Appendix B: Cost Function

In the model, there is not a single cost function for each industry but a series of nested cost functions, each with the translog form. Nesting the cost function is required to reduce the number of parameters to be estimated to a manageable number. The tier structure used to nest the cost functions is shown in the tree in Figure 5. An aggregate commodity and its components inputs will be called a "node" of the structure. The top node has a sector's final output created from capital, labor, energy, and materials, while lower nodes are aggregates of particular energy and material commodities. Except for final output at the top level, an aggregate commodity is not a real good, but a basket created from inputs which, at the lowest level, are all real goods.

For example, the aggregate commodity MO is made from the inputs MOT, commodity 23 (construction), and commodity 53 (real estate and rental and leasing). MOT is itself an aggregate commodity made from commodities 42 (wholesale trade), 44 (retail trade), and 48 (transportation and warehousing). At the lowest level, aggregate commodities are created from the 21 sector output commodities. Note that the price of a particular sector's output is constant across industries at a particular time but the price of aggregate commodities like energy will vary across industries in the same time period.

For each aggregate commodity (node) x and each industry, the translog cost function to be estimated is

$$\ln\left(c_x\right) = \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \beta_{ij}^{substitution} \ln(p_i)\ln\left(p_j\right) + \sum_{i=1}^{N} \beta_i^{shareconstant} \ln(p_i)$$

$$+ \sum_{i=1}^{N} \beta_i^{sharetrend} \ln(p_i)t + \beta^{costtrend} t + \beta^{constant}$$

where $\ln\left(c_x\right)$, the log cost of producing commodity x, is a function of the log input prices $\ln\left(p_i\right)$ of the N inputs indexed by i and the year t. [23] [24] The variables $\beta_{ij}^{substitution}$, $\beta_i^{shareconstant}$, $\beta_i^{sharetrend}$, $\beta^{costtrend}$, and $\beta^{costconstant}$ for the inputs i and j are the

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[23] We omit the subscript to identify the industry for which a variable applies since almost all variables, such as the parameters to be estimated and the input and output prices of aggregate commodities, are industry specific.
[24] The value of N ranges from one to four and is defined by the particular node according to Figure 5. It varies across nodes but is the same at any particular node across industries.

parameters to be estimated at this node. Intuitively, $\beta_{ij}^{substitution}$ defines how use of input i responds to changes in the price of input j and vice versa. $\beta_i^{shareconstant}$ is an intercept that gives the value share of input i at the node when time and all log input prices are zero. $\beta_i^{sharetrend}$ defines how much the value share of input i changes in one year if input prices do not change. $\beta^{costtrend}$ is a productivity parameter that defines how much the cost of output changes over time. The final price of output is calculated by taking the cost of output $\ln\left(c_x\right)$ and multiplying by the statutory tax rate. For lower nodes, their price is equal to their cost.

Figure 5: The tier structure of production
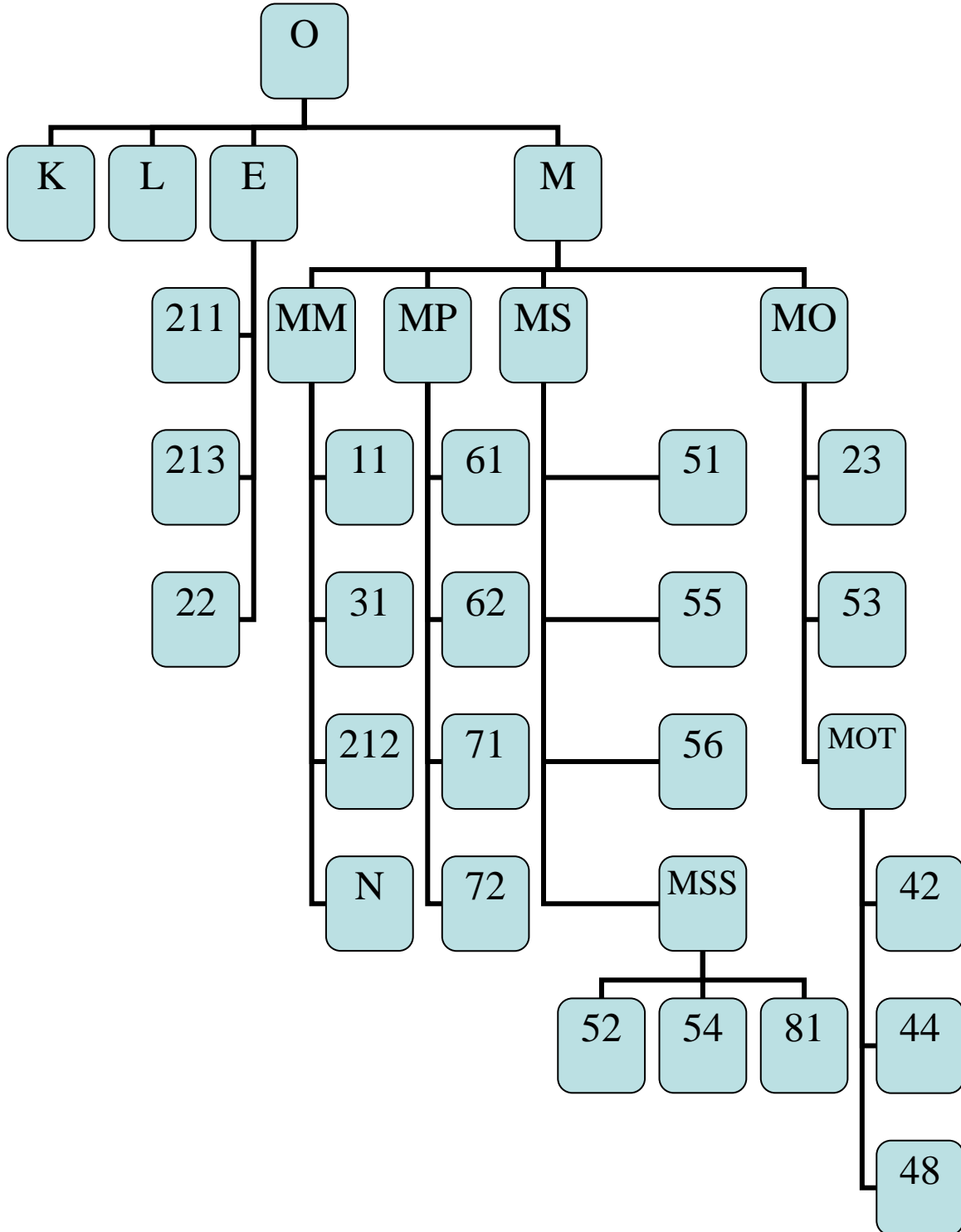
Notes: K is capital, L is labor, O is output, and N is non-competing imports. Numbers give the NAICS code of the respective sector. All other letters are the names of aggregate commodities.