Fossil Fuel Taxation in the President's 2013 Budget

by

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Abstract

The president's fiscal year 2013 budget proposes changes to the taxation of fossil fuels in the United States by increasing tax rates, reinstating expired taxes, and eliminating production deductions. The stated rationale for these changes is to remove tax preferences that encourage more investment in fossil fuel production than would occur under a neutral tax system. This paper evaluates whether the proposal accomplishes this goal. We do so by looking at the neutrality of the individual changes proposed, the overall tax treatment of fossil fuel production, and the effect the proposal will have on fossil fuel production. We first identify the changes proposed in the budget and compare them to both current law and a neutral tax system. We find that some of the proposed changes increase the neutrality of the system while others decrease it. We then move to look at the overall tax treatment of fossil fuel production in order to determine if the tax code gives preferential treatment to fossil fuel production. Surveying past literature on the effective tax rate on capital shows a wide variety of estimated tax rates for the sector. We calculate our own measures of the effective tax rate for the sector using three different specifications. Under all three of our measures, the effective tax rate for fossil fuel production is higher than the average for other sectors. Finally, we predict the effect of the proposal on fossil fuel production using a general equilibrium model of the US economy. We find that the proposal would increase the price of fossil fuels by 1.8 to 2.7 percent, decrease demand for fossil fuels by 0.7 to 1.7 percent, and that the excess burden of the additional revenue is 60 percent of revenues higher than if the tax increase was spread over all sectors. The price of the proposal's reduction in carbon dioxide emissions is estimated to be at least $69 per metric ton.

I. INTRODUCTION

The Department of the Treasury and the Joint Committee on Taxation have stated that the US federal tax code contains tax preferences that favor the production of fossil fuels more than a neutral tax code would (Department of the Treasury 2012; Joint Committee on Taxation 2012). The president's fiscal year 2013 budget proposes to make the Internal Revenue Code more neutral through significant changes to the taxation of fossil fuels production. These changes include increasing tax rates, reinstating expired taxes, and eliminating deductions. This paper discusses the ten most important tax changes contained in the proposed budget: (1) increasing the Oil Spill Liability Trust Fund financing rate, (2) repealing expensing of intangible drilling costs (IDCs), (3) repealing percentage depletion for fossil fuels, (4) repealing the domestic manufacturing deduction for fossil fuels, (5) increasing the geological and geophysical amortization period for independent producers, (6) repealing the capital gains treatment of coal royalties, (7) repealing expensing of exploration and development costs for coal, (8) repealing the last-in, first-out (LIFO) method of accounting for inventories, (9) reinstating the Superfund excise taxes, and (10) modifying the tax rules for dual capacity taxpayers.[1]

Revenue estimates of these changes from the Department of the Treasury (2012), hereafter Treasury, and the Joint Committee on Taxation (2012), hereafter JCT, are presented in Table 1. By either measure, the changes listed above will provide over 99 percent of the revenue increases brought about by the changes in the budget proposal that are specific to fossil fuel production.

Table 1: Revenue Estimates of Provisions of President's 2013 Budget for 2013-22 ($ millions)

	JCT (2012)[1]	Treasury (2012)
Repeal LIFO inventory accounting for all sectors	66,872	73,782
Repeal percentage depletion for oil and gas	12,099	11,465
Modify tax rules for dual capacity taxpayers	9,571	10,724
Repeal expensing of intangible drilling costs	9,529	13,902
Reinstate Superfund excise taxes[2]	6,538	8,225
Repeal the domestic manufacturing deduction for fossil fuels[3]	3,662	0
Repeal percentage depletion for coal and other hard mineral fossil fuels	1,310	1,744
Increase geological and geophysical amortization period	957	1,400
Repeal the capital gains treatment of coal royalties	612	422

[1] These changes were earlier identified as the most important for fossil fuel production by Pirog (2012).

Increase Oil Spill Liability Trust Fund financing rate	462	717
Repeal expensing of coal exploration and development	279	440
All other fossil fuel specific provisions	141	182

Notes: (1) The JCT revenue estimates are actually for 2012-22. However, for all provisions except the repeal of the capital gains treatment of coal royalties, revenues for 2012 would be 0. For that provision, 2012 revenues are $2 million.
(2) This is the revenue estimate for all 3 Superfund excise taxes combined. Only one of the three, a tax on petroleum, is relevant to the energy industry. However it accounted for 68% of total Superfund excise tax revenue from 1991-1995 (Ramseur, Reisch, and McCarthy 2008).
(3) This is the revenue estimate for the net effect of both repealing the production deduction for fossil fuels and increasing it for certain advanced technology. Treasury (2012) estimates the revenue raised from just the repeal at $11,883 million and Office of Management and Budget (2012) estimates the revenue from just repeal at $11,612 million.

The Obama administration has made a standard tax neutrality argument to justify the need for these tax changes. The president has stated that because of these provisions, fossil fuel production faces a lower tax rate than other sectors of the economy (Office of the Press Secretary 2012). Treasury (2012) expands on this claim to explain how these provisions are tax preferences should be repealed because they distort markets by causing more investment in fossil fuel production than would occur under a neutral tax system. Treasury mentions reduced energy security, higher carbon emissions, and higher taxes on the rest of the economy as consequences of this distortion. In this paper, we attempt to evaluate these arguments. We examine the effect the proposals will have on the neutrality of the tax code, measure the tax preferences fossil fuel production receives compared to other industries, and predict the effect this proposal would have on fossil fuel production.

We first discuss each change proposed by the budget, and compare it to both current law and how previous literature has determined that the issue would be treated under a neutral tax system, i.e., one that does not cause firms to change their economic behavior. Then we look at the taxation of fossil fuel production as a whole, specifically as it compares to other industries. We discuss different methods for calculating the tax rate for fossil fuel production and review past results. In addition, we present new estimates of the average effective tax rate of fossil fuel production.

In the last section, we look at the effects the tax changes will have on the prices and quantities of goods produced by each sector in the economy. We utilize a computable general equilibrium model of the United States and compare prices and quantities under the proposed budget to raising the same amount of revenue via a uniform ad valorem excise tax on all sectors. We find that the changes the budget proposes to the taxation of fossil fuels will lead to higher fossil fuel prices and lower demand. We also find that the excess burden of the revenue raised under the proposed budget is higher than if the revenue were instead raised with a broad based tax increase. We also calculate the implied cost of the carbon dioxide emission reductions attributable to the budget proposal.

This paper is organized as follows. Section II discusses each change proposed in the budget, and compares it to both current law and a neutral tax system. Section III discusses the overall tax treatment of fossil fuel production in comparison to other sectors. Section IV discusses the construction and results of the general equilibrium model. Section V summarizes and concludes.

II. COMPARISON OF CURRENT LAW, PROPOSED CHANGES, AND A NEUTRAL TAX SYSTEM

In this section, we will list the major changes proposed by the President's 2013 Budget Proposal, describe current law, discuss what the proposal will and will not change relative to current law, and then compare current law and the proposed changes to treatment of these issues under a neutral tax system. In order to discuss why a neutral tax system is desirable, we need to discuss what neutrality is and that requires explaining the costs of taxation. All taxes impose two types of costs on taxpayers: direct costs from money that is transferred from the taxpayer to the government and indirect costs due to firms and consumers expending resources to reduce their direct tax payments by substituting away from taxed activities.

The tax code is neutral if it does not influence economic choices such as firm organizational form, technology, and industry so that taxpayers make their decisions on economic and not tax criteria. A neutral tax code would thus have no excess burden. However, it is not possible for most taxes to completely eliminate their excess burden so a neutral tax system in this context refers to a minimally distortionary one instead of one that is completely distortion free. The exact features of a neutral tax system are a subject of disagreement among scholars. In cases where there is no consensus on how a particular feature of the tax code would look under a neutral tax system, we will compare present law to each of the options advocated by the literature.

II.A. Oil Spill Liability Trust Fund

Currently an excise tax of 8 cents per barrel is imposed on crude oil produced in the US and crude oil and petroleum products imported into the US. This tax is scheduled to increase to 9 cents per barrel in 2017 and then expire in 2018. However, the excise tax has been repeatedly extended since its creation in 1990 and is assumed to be permanent for federal budget scorekeeping purposes (JCT 2011). The proceeds from this excise tax are deposited in the Oil Spill Liability Trust Fund, which is used to pay for various costs resulting from oil spills and their subsequent cleanup and also government oil spill prevention and response programs (Treasury 2012). The fund pays for claims that are not covered by the responsible party, up to a $1 billion per incident limit and can reimburse the responsible party for some oil spill cleanup costs if the spill was not caused by negligence or violation of Federal regulations.[2] For the purposes of this tax, "crude oil" does not include synthetic petroleum or unconventional crudes. This means that domestically produced shale oil, refined oil, and liquids from coal, tar sands, and biomass, and are not taxed (JCT 2012). Refined oil is taxed if imported because it is included under "petroleum products" but imported tar sands are not (Internal Revenue Service 2011b).

The President's 2013 Budget proposal increases the excise tax to 9 cents per barrel for 2013-2016 and to 10 cents per barrel for 2017 and onwards (Treasury 2012). The tax would also be extended to apply to crudes that are produced from bituminous deposits and kerogen-rich rock (Treasury 2012).

In the case of smaller oil spills, strict civil liability for the full costs of the oil spill is optimal as it fully internalizes both the cost of the oil spill and the cost of prevention. The main argument for a trust fund is the case of catastrophic oil spills where the damages exceed the ability of the responsible party to pay. Previous literature has advocated two solutions to dealing with catastrophic oil spills: mandatory insurance and a prospective excess liability tax (Viscusi and Zeckhauser 2011; Cohen et al. 2011). Under a prospective excess liability tax, responsible parties would still face full strict liability but a tax would also be imposed and the federal government would pay for any damages that exceed the value of the responsible party's assets. This tax's rate would need to be actuarially fair with respect to the probability the activity causes an accident that could not be covered by the responsible party's assets.

The excise tax used to fund the Oil Spill Liability Trust Fund is much closer to a prospective excess liability tax than mandatory insurance, so that is the comparison we will make to judge the neutrality of the tax. However, the trust fund's excise tax differs from a prospective excess liability tax in two ways: it does not have an actuarially fair rate and has only limited liability. And the president's proposal to increase the financing rate and extend it to other forms of oil production would exacerbate the problem.

A neutral excise tax has an actuarially fair financing rate. However, there is no evidence the current rate of 8 cents per barrel or the president's proposed increase to 9 cents per barrel are based on the expected cost to the trust fund per barrel produced. And ideally, the rate would also vary with the level of safety taken by the firm, although the benefits of a more accurate rate need to be weighed against the difficulty of administrating such a tax. However extending the tax to include unconventional deposits would further decrease its accuracy since the extraction of crude from oil sands on land (or in fact, any land based oil extraction) does not run the risk of the type of a catastrophic oil spill like the Deepwater Horizon (Macondo) spill.

[2] Responsible parties are reimbursed for cleanup costs over a fixed amount that depends on the size of the vessel or facility the spill occurred at. However, Woods (2008) notes that the standards used to prove that the responsible party was not negligent can make it difficult for responsible parties to receive this reimbursement.

In addition, it is worth noting that the purpose of the tax is to pay for catastrophic oil spills that exceed the responsible party's ability to pay, not smaller oil spills for which the responsible party can pay. Thus a neutral tax rate would also need to take into account the lower rate of default for large firms with deep pockets by charging them a lower rate for the same activity. For the Deepwater Horizon oil spill, BP set up a $20 billion fund that had paid $4.7 billion as of July 2011, far exceeding the fund's $1 billion cap (Yost 2011). The probability that an oil spill would exceed the roughly $100 billion assets of a major integrated oil company like BP would be extremely small, and thus the actuarially fair tax rate would be similarly small (Abraham 2011). This is one of the few places in the tax code where different tax treatment of small firms and major integrated oil companies can be justified.

Although firms would face full strict civil liability under a prospective excess liability tax regime, under current law liability is limited in two ways. Total payouts by the trust fund are limited to $1 billion per incident. But with this cap, the trust fund could not fully cover the damages of the Deepwater Horizon oil spill if BP had defaulted. The trust fund also limits the liability of responsible parties for oil spill if they were not negligent and did not break federal regulation. This creates a moral hazard for firms to follow the minimum level of oil spill avoidance required by law, instead of the socially optimal level ensured by full strict civil liability.

II.B. Expensing of Intangible Drilling Costs

Intangible drilling costs (IDCs) are expenditures made in preparation of wells for the production of oil, natural gas, or geothermal energy that are not for the purchase of tangible property. For example, wages and fuel are examples of IDCs but pipelines are not (Treasury 1984). Most taxpayers may elect to either expense or capitalize these costs. Integrated oil companies, however, are not allowed to fully expense IDCs but must capitalize 30% of intangible drilling expenses over a 60-month period (JCT 2012).

The President's 2013 Budget proposal repeals both the expensing and 60-month amortization of IDCs (Treasury 2012). Intangible drilling costs instead would be capitalized as depreciable or depletable property (Treasury 2012).[3] Although the expensing of intangible drilling costs is not exclusively for oil and natural gas but also geothermal energy, both JCT (2012) and Treasury (2012) only discuss repeal for fossil fuels, not geothermal.

Under a neutral income tax system, expenses relating to the creation of a capital asset should not be expensed, but capitalized, with the tax depreciation allowance equal to the economic depreciation rate of the capital asset produced. However, it is not clear what generally applicable rules would then apply to IDCs nor what the true rate of economic

[3] Typically, depreciable assets are used to recover depletable assets (JCT 2012).

depreciation is. It is thus not possible to compare whether the old or new rates are closer to the economic rate of depreciation.[4] However, one clear advantage of this change is that it would remove the different tax treatment between firms due to organizational form since it would remove a deduction not available to integrated oil companies.

II.C. Percentage Depletion

Depletion deductions are similar to depreciation deductions. They are both deductions taxpayers receive as an asset is reduced in value as it produces income. For fossil fuels, the cost of acquiring the lease for the property is allowed to be deducted through depletion instead of depreciation (JCT 2012). The tax code recognizes two methods for the calculation of depletion deductions: cost depletion and percentage depletion.[5] Under the cost depletion method, each year the taxpayer deducts an amount equal to the amount of the resource recovered that year times the cost of acquiring the lease divided by the total amount of the resource in the property. Under the percentage depletion method, a constant percentage, varying from five to 22 percent (depending on the type of material extracted) of the taxpayer's gross income from a producing property is allowed as a deduction from net income in each taxable year (JCT 2012).[6]

A disadvantage of percentage depletion is that it does not depend on the costs of acquiring the property and thus has no direct relationship to cost recovery. GAO (2000) finds over the years 1968-2000 government revenue was decreased by a total of $82 billion in year 2000 dollars because of the greater deductions available to the petroleum industry in percentage depletion compared to cost depletion. In addition, cumulative depletion deductions may be greater than the amount expended by the taxpayer to acquire the property in the first place (JCT 2012).

The President's 2013 Budget proposal would repeal the percentage depletion deduction for fossil fuels but retain it for other mining (Treasury 2012). All properties and firms engaged in fossil fuel extraction would use the cost depletion method instead (Treasury 2012).

In isolation, percentage depletion is non-neutral. The percentages are chosen based on non-economic criteria such as the type of resource being extracted and eligibility varies depending on firm organizational form. Percentage depletion is also not directly linked to the cost of the actual capital invested. If this tax were revised to be neutral, is unclear what the optimal deprecation rate would be. But using the rate at which minerals are removed from the property as the deprecation rate

[4] There is no reference in the proposal to what the new rules are or if there even is a single set of rules which would now apply to all IDCs. It appears expenditures that were grouped together under the category of IDC would now have a variety of different treatments based on the type of expenditure they are.
[5] Additional explanation of the two depletion methods is available in IRS (2011a).
[6] Other limitations on percentage depletion exist as well. For example, for non-integrated oil companies, the deduction is limited to domestic US production on the first one thousand barrels per day per well and is also limited to 65% percent of net income on that particular property. Integrated oil companies are not allowed to use the percentage depletion deduction at all (Smalling 2012).

(as cost depletion does) would at least ensure that full write off only occurs when all the minerals are removed from the property. So it appears to be a more neutral method than using percentage depletion.

However, including other taxes into the analysis increases the favorability of percentage depletion. In 2011, 35 of the 50 states imposed a severance tax on the extraction of natural resources (Telles, O'Sullivan, and Willhide 2012). These taxes are usually imposed at a flat rate per unit of measure (per ton of coal, per barrel of oil, etc.) (Zelio and Houlihan 2008). In addition, as part of the lease allowing companies to extract minerals from federal land, the federal government charges royalties which in 2006 were 12 ½ to 16 ⅔ percent of the value of oil and gas extracted and $0.15 to $1.75 per ton extracted for coal (Minerals Management Service Minerals Revenue Management 2006). However, such taxes or lease terms are distortionary because they reduce the marginal revenue of additional extraction compared to its marginal cost, causing early shutdown of otherwise still productive property. A percentage depletion allowance less than or equal to the severance tax or royalty rate would be efficiency enhancing by effectively canceling out part of the severance tax or royalty and thus increasing production.[7]

In addition, the percentage depletion deduction is repealed for fossil fuel extraction only, not all minerals. But the arguments for and against percentage depletion in fossil fuel extraction also apply to mining for other resources, which would retain their percentage depletion deduction under the proposal. Under a neutral tax system, all forms of extraction would have uniform depletion rules that do not vary based on the material extracted.

This means that the repeal of percentage depletion has two effects. It increases the neutrality of the code because percentage depletion is itself distortionary. But it also reduces the neutrality of the code by eliminating a deduction that offset distortionary taxes and lease terms and through favoring non-fossil fuel extraction over fossil fuel extraction. The net effect of these two effects is unclear.

II.D. Domestic Manufacturing Deduction

The domestic manufacturing deduction was added to the tax code with the American Jobs Creation Act of 2004 with the intent of encouraging domestic investment and improving the competitiveness of US manufacturers in global markets (Blouin, Krull, and Schwab 2007). It allows a taxpayer to deduct a percentage of their income derived from domestic manufacturing activities (Pirog 2012). The percentage of the deduction is six percent for oil and gas production and is otherwise nine percent.

[7] Although using percentage depletion to cancel out royalties would mean the original purpose of the depletion deduction, recovering capital costs incurred in acquiring the property, would not be served.

The President's 2013 Budget proposal would repeal the domestic manufacturing deduction for income derived from the domestic production of oil, gas, coal, other hard mineral fossil fuels, and certain other nonmanufacturing activities (Treasury 2012). The deduction rate would also be increased to 18 percent for activities involving the manufacture of certain advanced technology property (Treasury 2012).[8] The domestic manufacturing deduction would be unchanged for other industries.

There are two margins on which this change needs to be considered: which industries receive the deduction and imports versus domestic production. In regards to first issue, the change would level the playing field between fossil fuels and industries that do not receive the deduction. But it would also increase the gap between still deductible industries and fossil fuels. In the case of the Treasury revenue estimate where this provision is revenue neutral, this is just the replacement of one non-neutral provision with equal spending on another that also causes a distortion and thus would not be expected to affect the neutrality of the code.[9]

The second dimension of the change is the choice between domestic production and importation. Eliminating the deduction would increase the favorability of importing fossil fuels instead of domestic production. The reverse effect would occur for the advanced technology property which would now receive a larger deduction. Although this paper will not attempt to weigh the merits of energy security against free trade, Treasury (2012) has mentioned improving energy security as one of the reasons for the tax changes. However, this effect would actually reduce US energy security by increasing the favorability of importing fossil fuels as compared to domestic production.

II.E. Geological and Geophysical Expense Amortization

Geological and geophysical (G&G) expenses are the costs incurred for acquiring data for minerals exploration and include expenditures on geologists, seismic surveys, gravity meter surveys, and magnetic surveys (JCT 2012). Independent producers and small integrated oil companies may amortize and deduct these costs over two years. Major integrated oil companies are required to amortize the deduction of G&G costs over seven years.

The President's 2013 Budget proposal would increase the amortization period for independent producers and small integrated oil companies from two years to the same seven years as major integrated oil companies (Treasury 2012). Major integrated oil companies would be unaffected.

[8] The proposal is quite vague on some of these terms. It does not define what the "certain other nonmanufacturing activities" that would lose the deduction are nor does it define what the "activities involving the manufacture of certain advanced technology property" are.

[9] Note that the JCT assumes the revenue gained from repeal is not fully channeled to funding additional deductions for advanced technology property and that the total amount spent on the deduction decreases (this provision generates revenue). If this were the case the net change in deadweight loss could easily be negative.

Under a neutral tax system, statutory G&G depreciation would equal economic depreciation and be the same for all firms regardless of organizational form. So it is appropriate that the President's proposal is to treat independent producers, small integrated oil companies, and large integrated oil companies equally. BEA (2003) calculates the geometric economic depreciation rate for petroleum and natural gas mining exploration, shafts, and wells at .0751 and lists a service life of 12 years.[10] So the increase in the amortization period for independent producers and small integrated oil companies would move their tax depreciation treatment closer to both economic depreciation and eliminate the difference in tax treatment due to firm organizational form. This change is thus neutrality enhancing.

II.F. Capital Gains Treatment of Coal Royalties

While in general royalties are taxed as ordinary income, royalty income from the sale of coal mined in the US and held for at least one year can be taxed instead as long term capital gains (JCT 2012). The President's 2013 Budget proposal would repeal the capital gains treatment of gains from coal royalties under these circumstances (Treasury 2012).

There are a variety of considerations that must be taken in dealing with the taxation of ordinary income versus capital gains in a neutral tax system to ensure that income invested and then earned again in a subsequent period is not double taxed. However, in this case these concerns can be safely sidestepped by focusing on the coal itself. Coal and coal royalties are not assets like property or stocks but inventories. Income from the sale of inventories is typically treated as ordinary income, not capital gains. This provision is thus neutrality enhancing.[11]

II.G. Expensing of Coal Exploration

Exploration is the process of determining if there are sufficient minerals in an area to justify mining. Under current law, taxpayers may elect to expense (immediately deduct) exploration costs in all types of mining, not just coal. Unlike other organizational forms of firms, corporations may only expense 70 percent of the exploration expenses and must amortize over a 60-month period the remaining 30 percent (Treasury 2012). This deduction is subject to recapture by disallowing percentage depletion deduction on the property for which exploration costs were expensed until "adjusted exploration expenditures" are re-included in income (JCT 2012).[12]

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[10] A summary of the BEA depreciation table as it is relevant to the energy industry is available in Table A1 in the Appendix of Metcalf (2009).

[11] Although it brings coal in line with the current law treatment of other inventories, the budget proposal does still deviate somewhat from a neutral system, which would allow inflationary gains to be deducted from income. This point is explained in detail later in this paper under the discussion of LIFO.

[12] Adjusted exploration expenditures are the amounts for which the taxpayer claimed an exploration deduction that would have been included in the basis of the property reduced by the excess of the percentage depletion over the depletion allowable had the expenses been capitalized instead (JCT 2012).

The President's 2013 Budget proposal would repeal the option to expense and amortize over 60-months exploration and development costs for coal (including lignite) and certain types of oil shales (Treasury 2012). The costs would instead be capitalized and recovered through depreciation or depletion deductions, as appropriate (Treasury 2012). Other forms of mining would retain the option to expense and amortize exploration costs.

Under a neutral tax system, a taxpayer would be allowed to deduct costs that benefit future periods based on the economic rate of depreciation. Exploration costs for a mine that is found to not have sufficient quantity or quality of ore to justify mining should be immediately expensed since they will provide no future benefit. However, for a productive mine, they should be deducted at their economic depreciation rate. As was stated before, BEA (2003) calculates the geometric economic depreciation rate for petroleum and natural gas mining exploration, shafts, and wells at .0751 and a service life of 12 years, a longer lifetime than the 60-month amortization allowed now. Retaining the deduction for other forms of mining would make the tax system less neutral in regards to which type of mining to invest in but would make the system more neutral for the choice of what type of capital to employ in coal mining.

II.H. Repeal Last-in, First-out (LIFO) Method of Accounting for Inventories

In general, taxpayers are allowed a deduction equal to the cost of acquiring the goods they sell. However, the appropriate value to deduct becomes unclear when the firm is selling goods from an inventory containing goods acquired at multiple time periods, each of which was bought at a different price. The LIFO and FIFO methods determine which price to use in this situation. Under last-in, first-out (LIFO), when a unit of a good is removed from inventory, the price of the last (most recent) unit of that good put into the inventory is used to calculate net income from the sale of the good. Under first-in, first-out (FIFO), when a unit of a good is removed from inventory, the price of the first (least recent) unit of the good put in inventory is used to calculate net income from the sale of the good. In order to use LIFO for tax purposes, a firm must also use LIFO for financial accounting purposes (Treasury 2012). Although LIFO accounting is not unique to firms that produce fossil fuels, some sources indicate repeal of LIFO will have a disproportionately large impact on the sector.[13]

When the price of an inventory item is increasing, such as due to inflation, current prices are above historical prices. In this case, cost of goods sold is higher under LIFO than FIFO. A higher cost of goods sold in a period translates to lower net taxable income and thus lower taxes paid in that period. The lower cost of goods sold from the less recent period is not

[13] The evidence on how much repealing LIFO would affect the energy sector is mixed. Przybyla (2011) and Knittel (2009) find that the energy industry has large LIFO reserves but have limited data sets. Table 1 of volume 2 of Treasury (1984) indicates the opposite but is much older.

used until inventories are drawn down. But if inventories are never drawn down, this lower cost of good sold is never used and those inventory items' appreciation, whether inflationary or not, is never taxed.

The President's 2013 budget proposal would repeal the LIFO inventory accounting method for income tax purposes, regardless of the use of LIFO on the firm's financial statement (Treasury 2012). Taxpayers that currently use LIFO would be required to write up their beginning LIFO inventory to its FIFO value in the first taxable year beginning in 2013 (Treasury 2012). The resulting increase in income is taken into account ratably over 10 taxable years beginning with the first taxable year beginning in 2013 (Treasury 2012).

In a neutral tax system, taxes should be imposed on real economic income, not increases that are attributable to inflation. Gains from inflation should not be taxed, but neither should an incentive be created to retain inventories. And inventory appreciation that is not due to inflation should be taxed. Treasury (1984) recommends satisfying these goals by allowing firms too choose between FIFO indexed for inflation or LIFO.[14] However, as previously noted, LIFO allows firms to defer taxes on the gains from their inventory appreciating by maintaining their inventory stock. So we recommend mandatory inflation indexed FIFO as the ideal method. However, the President's proposal is for non-indexed FIFO. Without indexing, it is unclear if the FIFO requirement proposed by the president would be more or less neutral than the current system.

II.I. Reinstate Superfund Excise Taxes

The Environmental Protection Agency maintains a list of polluted sites called the National Priorities List. For 70 percent of the sites on the list, the EPA can locate potentially responsible parties (PRPs) who pay for the site's cleanup (Ramseur, Reisch, and McCarthy 2008). For the remaining 30 percent of sites, either the EPA cannot locate the PRP or the PRP cannot afford to pay for the cleanup (Ramseur, Reisch, and McCarthy 2008). Cleanup at these "orphaned" sites are paid out of the Hazardous Substance Superfund Trust Fund (Superfund). Since the expiration of three excise and one income tax which originally funded the Superfund, the Superfund is now paid for out of general revenues (Ramseur, Reisch, and McCarthy 2008).

The President's 2013 Budget proposal would reinstate all four Superfund taxes for the years 2013 through 2022 (Treasury 2012). Two of the excise taxes would not apply to the energy industry while the income tax would apply to all

[14] Kleinbard, Plesko, and Goodman (2006) note that inflation affects all capital investment, not just inventories, and thus should be dealt with in a systematic manner instead of through LIFO as a piecemeal solution affecting only inventories would favor investment in one form over another. However, a neutral tax system would allow inflation indexation for both inventories and capital investment.

corporations. The only tax of specific relevance to the energy industry is the remaining excise tax, a 9.7 cent per barrel excise tax on domestic crude and on imported petroleum products.

Under a neutral tax system, polluted site cleanup would be handled in the same manner as oil spills. We therefore propose the same solutions discussed in greater detail under the Oil Spill Liability Trust Fund. Impose full civil liability for small amounts of pollution and either require firms to purchase excess liability insurance or impose an actuarially fair tax on activities with the possibility for catastrophic pollution that would exceed the firm's ability to pay.

The Superfund excise tax has a similar problem to the Oil Spill Liability Trust Fund. The excise tax is not actuarially fair: it is paid by all firms who produce or import petroleum, at the same rate regardless of the care taken by any firm to avoid polluting or the firm's risk of defaulting on cleanup costs. This creates a moral hazard for small firms with a high risk of default and therefore does not internalize the cost of pollution cleanup.

However, the Superfund is less problematic in that the excise tax is only used to pay for orphaned sites. Under current law, if the PRP can be identified and is able to pay, then the PRP pays for cleanup at the site. Yet for the orphaned sites, it does not internalize the cost of cleanup if a firm can avoid responsibility if its assets are less than the cost of the pollution damages. But the case of orphaned sites whose PRP cannot be identified complicate the analysis. It is not clear why the PRP cannot be identified in these cases. If the inability to identify the PRP would also prevent identification of their insurance, then an actuarially fair tax would be more neutral than requiring excess liability insurance.

II.J. Modify Dual Capacity Rules

The US taxes domestic corporations on the income they earn in foreign countries. However, since the host country can also impose income taxes on the income of corporations earned in that country, this can lead to double taxation of that income. To avoid double taxation, the US tax code allows firms to credit certain foreign levies against their US tax liability. A foreign levy is creditable against the firm's US tax liability if it is compulsory and is not compensation by the firm to the host nation for a specific economic benefit.[15] A "dual-capacity taxpayer" is a taxpayer who is subject to a levy by a foreign country that also receives a specific economic benefit from that country.[16]

The tax code allows taxpayers to choose between two methods to determine the portion of the levy paid by the taxpayer which is compulsory and creditable, and the portion which is compensation for a specific economic benefit and deductable.[17] [18] Under the facts and circumstances method, a levy is creditable to the extent that the taxpayer is able to prove

[15] Treasury Regulation section 1.901-2(a)(2)(i).
[16] Treasury Regulation section 1.901-2(a)(2)(ii)(A).
[17] Treasury Regulation section 1.901-2A(c).

that portion of the levy is not paid as compensation for specific economic benefits.[19] Under the safe harbor method, if the host country has a generally imposed income tax, the taxpayer may credit an amount equal to the tax payment that would result from application of the host country's generally imposed income tax (JCT 2012). In either case, the foreign tax credit is limited to a taxpayer's US tax liability on its foreign source income (JCT 2012).[20]

The President's 2013 Budget Proposal would eliminate the current safe harbor and facts and circumstances methods for determining the fraction of a levy that is creditable (Treasury 2012). Under the new rules, dual capacity taxpayers would be able to treat as creditable the portion of a foreign levy that does not exceed the foreign levy that the taxpayer would pay if it were not a dual-capacity taxpayer (Treasury 2012). In effect, dual capacity companies would only be able to credit an amount equal to the host nation's general corporate tax rate applicable to other industries (Pirog 2012). This is similar to simply forcing firms to choose the safe harbor method. In addition, the special limit for oil and gas income tax credits would be removed and it would instead be treated as its own separate limitation category (Treasury 2012).

If US dual capacity firms operating outside the US are able to use creditable royalty payments to reduce their tax rate below that faced by other US based firms operating outside the US, who have to pay for economic benefits through deductible but not credible expenses, then removing these credits enhances of the tax code. However, it is unclear that simply forcing all firms to credit taxes using the general corporate tax rate separates the taxes are true income taxes from the taxes that are payments for economic benefits more accurately than the nuanced calculation allowed by the facts and circumstance rule. Indeed, to the extent that it is accurately applied, the facts and circumstances method seems ideal.

Distinct from possible differentials between sectors, another issue is whether foreign source income of US based firms should be taxed at all. There are two major systems states use for the taxation (or non-taxation) of foreign source income. Under a pure residence base tax system, countries tax their residents (and domestic firms) on their worldwide income. Alternatively, under a territorial tax or source-based tax system, a country only taxes income that is earned within its borders.

Previous literature has not come to a consensus on which system is superior.[21] However, Gravelle (2009) notes that that the US is only nominally a residence based tax system. Under current law, firms only pay taxes on income that is repatriated back to the US and are allowed to indefinitely defer repatriation. This significantly reduces the US tax they pay on

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[18] These rules were designed because of concerns that income taxes imposed on US oil companies by foreign governments were not income taxes but disguised royalties, which are normally deductable but not creditable (JCT 2012).
[19] Treasury Regulation section 1.901-2A(c)(2)(i).
[20] JCT (2012) explains how two additional rules also apply. The credit is restricted by the category of income, generally referred to as "separate limitation category," so that tax credits from a particular category of income can only offset tax liabilities from that same category of income. In addition to the special limitation categories, credits from oil and gas income taxes may only offset oil and gas income tax liabilities.
[21] Kleinbard (2007) and Gravelle (2012) advocate residence based taxation. Desai and Hines (2004) argue in favor of territorial based taxation

foreign source income. In this case, Gravelle (2009) states that a move towards either a more pure residence or territorial tax system would enhance the neutrality of the tax code. Exempting foreign source income entirely and moving to a territorial tax system would encourage the repatriation of income by reducing its tax rate. Alternatively, the tax code could move to a more effective residence system by ending deferral, which would encourage the repatriation of income and also increase the effective tax rate on foreign source income.

The President's proposed changes use neither of these methods. By reducing deductions, the difference in effective tax rate between repatriated and deferred foreign source income increases. If the goal is to increase the effective tax rate on foreign source income to be closer to the effective tax rate on domestic income, it should not be done in such a way that would increase the incentive to defer repatriation of foreign source income. This decreases the neutrality of the tax code.

III. OVERALL TAX TREATMENT OF FOSSIL FUEL PRODUCTION

It is important to frame the discussion of the individual tax changes proposed by the President in the context of the existing taxes and deductions faced by fossil fuel producers. The President himself noted that "these companies pay a lower tax rate than most other companies on their investments, partly because we're giving them billions in tax giveaways every year" (Office of the Press Secretary 2012). Treasury (2012) also stated that tax preferences encourage more investment in fossil fuel production than would occur under a neutral tax system. Although neither provided a citation for their claim, there has been significant research in recent years on the tax rates faced by the energy sector, and at least one paper that did find that investment in energy capital faced a lower tax rate than other types of capital (Congressional Budget Office 2005).

However, before we can discuss previous estimates of effective tax rates, we first need to discuss exactly which taxes we are interested in and how we plan to measure them. Which taxes to include depends on the inference to be drawn. For example, in order to calculate the effective long run tax rate on oil industry capital, severance taxes should not be included since they are borne by landowners in the form of lower resource payments (bonus bids, royalties, etc.). But a severance tax on oil could still be non-neutral, if the distortions occurred on different margins. Lowering the payments resource owners receive could lower the overall level of oil production from the pre-tax amount by encouraging alternate land use or early shutdown of the well. Therefore, since we are interested in total production, it is appropriate to look at all taxes. We will do so by calculating the average effective tax rate for fossil fuel production.

Although we are looking at the actual average effective tax rates, a separate issue is determining what the optimal tax rates are. For example, higher tax rates on fossil fuel production than on other sectors could be justified as Pigouvian taxation on negative externalities or in order to capture resource rents. The aforementioned severance tax on oil could be efficiency enhancing if it was set equal to the cost of pollution remediation per barrel. However, since there is still uncertainty on what actual tax rates are, we feel it is appropriate to focus on that issue and leave the determination of the optimal rate aside. This means that our analysis cannot indicate if the current tax rate on fossil fuel production is “too high” or “too low”. We only determine if it is higher or lower than other sectors. However, we will revisit the issue of externalities caused by fossil fuels when we calculate the budget proposal’s per ton cost of carbon dioxide emission reductions in Section IV.

III.A. Types of Taxes on Fossil Fuel Production

III.A.1. Capital Taxes

The main taxes imposed on capital income are state and federal corporate income taxes and personal income taxes on capital gains and dividends. The effect of these taxes on the pre-tax and post-tax rates of return is summarized through the effective tax rate (ETR) on investment. The effective tax rate is the amount capital taxes reduce the pre-tax rate of return on investment. For example, if investment in a new oil well earned a pre-tax 10 percent return but taxes reduce that return to 6 percent, the effective tax rate would be (10-6)/10 = 40 percent. An effective tax rate differs from the statutory tax rate in that it applies to the income earned over the lifetime of an investment and is able to account for the effects of inflation, the difference between tax and economic depreciation, and the difference in the taxation of returns to debt and equity.

The marginal effective tax rate (METR) is the tax rate for the marginal investment, the investment that earns a rate of return exactly equal to the cost of capital. The marginal investment is the critical one for determining the aggregate level of investment because a firm will invest in all investments opportunities with higher post tax rates of return than the break even rate and not invest in any with lower. Reducing the rate of return of an investment which is currently at the break even rate would cause the firm to no longer undertake the project and thus reduce aggregate investment.

We have several estimates of the marginal tax rate for different types of capital assets from previous work by Congressional Budget Office (CBO) (2005), Ernst & Young (2007), and Metcalf (2009). CBO (2005) calculates the METR from federal taxes for a wide variety of very broad asset categories.[22] Their results are summarized in Table 2. They find the overall METR on capital assets from all businesses is 24.2 percent and the METR on corporations is 26.3 percent. The METRs for C corporation assets in the fossil fuel industry vary from 9.2 to 24.9 percent.

[22] The taxes included in the CBO analysis are federal taxes on corporate profits, dividends, long-term capital gains, short-term capital gains, interest income, mortgage interest deductions, unincorporated business income, and distributions from nonqualified annuities. See CBO (2005) Table A-4 for more details.

Table 2: CBO (2005) Estimates of Marginal Effective Tax Rates for Different Types of Capital

Asset Type	METR (%)	Share of Corporate Assets (%)
Overall businesses	24.2	
Overall corporations	26.3	
Capital income of C corporations, by asset type		
Electric structures	18.6	5.4
Petroleum and natural gas structures	9.2	3.2
Electric transmission and distribution	24.9	2.4
Other power structures	19.0	2.1
Mining structures	9.5	0.3
Mining and oil field machinery	21.9	0.2
Other electrical equipment	24.8	0.1

Ernst & Young (2007) looks at the energy sector specifically but only includes the federal corporate income tax in their calculation. They find a 21.6 percent METR for petroleum refining. Metcalf (2009) provides another calculation of the METR of assets used in fossil fuel production. Metcalf's calculation includes some tax credits, but the only taxes included are the federal corporate income tax and the average state corporate income tax. His results show significant variety in the METR faced by different capital assets in the energy sector, with METRs ranging from a high of 27.0 percent for other natural gas pipelines to a low of -13.5 percent for oil drilling by non-integrated firms. However, his METRs for oil drilling by integrated firms, petroleum refining, and natural gas gathering pipelines are all in the range of 15.2 to 19.1 percent.

III.A.2. Other Taxes

In addition to capital taxes, fossil fuel production faces a large number of other taxes such as sales, property, severance, and excise taxes. As seen in Table 3, total payments for these taxes, less subsidies, by fossil fuel producing sectors exceed payments for corporate income taxes.[23] However, I can not locate any previous literature that combines and summarizes the effect of these taxes, either with each other or with capital taxes, the way the METR literature has done for taxes on capital investment. In the next section, we attempt to do so for the combined effect of capital and other taxes by calculating average effective tax rates (AETR).

Table 3: Total Tax Payments by Industry, 1998-2009 ($ million)

Sector	Corporate Income Taxes	Other Production Taxes
Oil and gas extraction	39,230	204,759
Petroleum and coal products	193,870	24,738

[23] Both corporate income tax statistics and the other production tax statistics include all such taxes at the federal, state, and local levels.

manufacturing		
Pipeline transportation	3,738	17,595
All these particular energy sectors	236,838	247,091
All sectors	3,627,248	9,785,265

Source: Author's calculation from BEA US Input-Output Accounts and NIPA Table 6.18D.

III.B. Average Effective Tax Rate

Although we are interested in calculating the ETR on fossil fuel production, there is no single ETR that captures every dimension of taxation. Therefore we will provide a number of ETR looking at different types of taxation and different bases. Our two main data sources are the Use of Commodities by Industries after Redefinitions tables for 1998-2009 in the US Input-Output accounts from the Bureau of Economic Analysis (BEA) and Table 6.18D: Taxes on Corporate Income by Industry in the 2012 National Income and Product Accounts, also by the BEA.[24] We will calculate the average effective tax rate for a selection of energy sectors and the whole economy by dividing total tax payments by both value added and gross income. We also calculate the average effective tax rate on capital for those same sectors by dividing corporate income tax payments by gross operating surplus.

Total tax payment equals taxes on production and imports plus state, local, and federal corporate income taxes minus subsidies.[25] Taxes on production and imports include taxes on the product delivery or sale of products and taxes on the ownership of assets used in production, such as federal excise, state and local sales taxes, and local real estate taxes. Corporate income taxes include those taxes at the federal, state, and local level. Value added is equal to gross operating surplus plus compensation of employees, plus taxes on production and imports, less subsidies.

We estimate tax burden using average effective tax rates (AETR) as opposed to marginal effective tax rates (METR). Collins and Shackelford (1995) and Fullerton (1984) discuss each measure and their advantages and disadvantages. METR calculations are designed to measure the tax cost on marginal incentives to hire labor or employ capital. However they are calculated theoretically and require numerous assumptions about firm financing, asset purchase decisions, and depreciation (Collins and Shackelford 1995).[26] In addition, the calculation must explicitly choose which provisions of the tax code (which deductions, which tax credits) to include and how to model them. As a practical matter, they must pick and choose what

[24] In an alternative specification, we instead use corporate income tax data from the Internal Revenue Service Statistics of Income Tax Stats on the Returns of Active Corporations by Minor Industry. These results show a smaller difference between all industries and the selected fossil fuel producers, but still indicate a lower tax rate for other industries than fossil fuels. However, this data set does not include state and local income taxes and has one less year of data. Full results are available upon request.

[25] Taxes on production and imports, subsidies, net operating surplus, and compensation of employees are defined in http://www.bea.gov/national/pdf/chapters1-4.pdf pages 2-8 to 2-9. Corporate income tax is defined in http://www.bea.gov/scb/pdf/NATIONAL/NIPA/Methpap/methpap2.pdf on page 3.

[26] See CBO (2006) for a more detailed description of the general method used to calculate METRs.

provisions to include and this will lead the calculation to miss the cumulative effect of numerous small or difficult to model features that are not included.

AETRs are calculating empirically by dividing a measurement of taxes paid by a measurement of the base of economy activity taxed. Because it is calculated from actual tax payments, it avoids the problems METR calculations face with having to make numerous assumptions and the being forced to pick and choose the features of the tax code to include. However, it measures the average tax rates on all investments as opposed to finding the tax rate on the marginal investment. It thus reflects the total burden of taxation instead of marginal incentives (Collins and Shackelford 1995).[27]

We combine all taxes together for the total tax calculation because, in the long run, all taxes will have certain effects no matter what the statutory base is. Due to capital mobility between sectors, a high (or low) tax rate on capital in a sector will not change the long run post-tax rate of return that capital employed in that sector receives. A similar argument applies for labor mobility to show that it is not borne by labor. And production taxes are the same too; in the long run, all these taxes will leave the sector with the same post-tax rate of return to capital and labor. But they will change the resource rent landowners receive, or the price consumers pay, or the total amount of domestic production, depending on the elasticities of each. Therefore adding all taxes together is appropriate for looking at these effects.

Deciding on the base is another critical component for calculating the AETR. To calculate the AETR on capital, we divide corporate income tax payments by gross operating surplus. But since previous work has focused almost exclusively on the average (or marginal) effective tax rate on capital, it is unclear which base is the most appropriate to use for the denominator of our total AETR calculation. Gross income would be a useful base for looking at the percentage increase in costs due to taxes because dividing total taxes by gross income gives the increase in output price over the price of inputs due to taxation. However, taxes in other sectors can also increase the cost of fossil fuel production due to tax cascading. The taxes imposed on other sectors increase the price of their output, output which is in turn used as intermediate goods in fossil fuel production. Thus the taxes directly paid by a sector are only a portion of the increase in their costs due to the tax system. To check how sensitive our results are to this issue, we also look at total taxes paid with value added as the base. A value added base does not include the cost of intermediate inputs and thus this measure would not be affected by cascading. We present results using both value added and gross income in the denominator.

[27] However, AETR is not without its own drawbacks. See Fullerton (1984) for a discussion of the problems of AETR.

III.C. AETR Estimates

Table 4 presents average effective tax rates on capital for selected sectors for 1998-2009. The average effective tax rate on capital in these fossil fuel producing sectors is 13.0 percent. This tax rate is 5.5 percentage points or 73 percent higher than the rate of 7.5 percent for all sectors. These results are driven by the extremely high tax rate on capital in petroleum and coal products manufacturing which is 21.4 percent. The other two sectors, oil and gas extraction and pipeline transportation have lower AETR than the average for all sectors.

Table 4: Average Effective Tax Rates on Capital by Sector, 1998-2009 (Percent)

Sector	Capital AETR
Oil and gas extraction	4.6
Petroleum and coal products manufacturing	21.4
Pipeline transportation	6.4
Fossil fuel production[1]	13.0
All sectors	7.5

Source: Author's calculation from BEA US Input-Output Accounts and NIPA Table 6.18D.
Notes: (1) Fossil fuel production is defined as oil and gas extraction, petroleum and coal products manufacturing, and pipeline transportation.

Table 5 presents average effective tax rates of all firm taxes for energy and other sectors for 1998-2009. As a fraction of value added, the average effective tax rate for the entire economy is 10.9 percent. The average rate for fossil fuel producing sectors is 19.7 percent, a difference of 8.8 percentage points and 81 percent higher than the economy wide rate. If total taxes paid are instead divided by the total value of output, the average effective tax rate for these fossil fuel producing sectors is now 7.4 percent. The AETR for all sectors is 1.5 percentage points lower at 5.9 percent. The AETR for oil and gas extraction is now the highest at 12.1 percent. Petroleum and coal products manufacturing now has the lowest AETR at 5.1 percent.

Table 5: Average Effective Tax Rates of All Taxes by Sector, 1998-2009 (Percent)

Sector	Value Added Base	Gross Income Base
Oil and gas extraction	19.3	12.1
Petroleum and coal products manufacturing	20.4	5.1
Pipeline transportation	16.7	7.4
Fossil fuel production[1]	19.7	7.4
All sectors	10.9	5.9

Source: Author's calculation from BEA US Input-Output Accounts and NIPA Table 6.18D.
Notes: (1) Fossil fuel production is defined as oil and gas extraction, petroleum and coal products manufacturing, and pipeline transportation.

The AETR on fossil fuels is higher than the AETR for other sectors under all three specifications. So for this measure of taxation, fossil fuel production is more heavily, not less, taxed than other sectors. However, this is the actual level of taxation, not the optimal level of taxation. And to reiterate, pollution externalities and resource rents could justify a higher level of taxation for fossil fuel production. But in order for further tax increases to be efficiency enhancing, pollution externalities need to not only exist but also be of sufficient size that they are larger than the already extant higher AETR on fossil fuel production compared to other sectors.

IV. GENERAL EQUILIBRIUM MODEL

So far we have given descriptive analysis of the proposed changes and followed it with an analysis of the current law level of taxes on fossil fuel production. Now we turn to examine the aggregate effect the changes to fossil fuel taxation proposed in the President's 2013 Budget will have on fossil fuel production and the rest of the US economy. We will calculate the effect the changes will have on the price of fossil fuels, their supply and demand, and calculate the excess burden of raising revenue by focusing on taxing fossil fuels as opposed to spreading the increase in tax burden over all sectors of the economy. As a final summary statistic, we also calculate a lower bound on the per ton cost of the proposal's carbon dioxide emission reduction.

IV.A. Model Description

In this section, we briefly describe the construction of the model we will use analyze the effects of the budget proposal. 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 general equilibrium model of the US economy. Our model is a simplified version of the model used by Jorgenson and Slesnick (2008) and Wilcoxen (1988). Finally, we look at the model under the proposed changes to the taxation of fossil fuels and compare the prices, output, demand, and excess burden that would result if the same amount of revenue was raised from taxing all sectors instead.

In the model, the cost function for an industry relates the cost producing the industry's output to the cost of the inputs – labor, capital, and all the outputs. Following Jorgenson and Slesnick (2008) and Wilcoxen (1988), we utilize a translog cost function. 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.[28] The cost function is exactly the same whether a particular unit of output produced by an industry is used by consumers or as an

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

intermediate good by another industry. However, the cost functions vary across the 22 industries. We assume all industries are perfectly competitive with constant returns to scale. These two assumptions ensure that the consumer price and post-tax cost of the output for each industry are identical. To get the consumer price, we take the pre-tax producer price given by the cost function and multiply it by one plus the tax rate.

We assume capital is perfectly mobile and labor is mobile between sectors but unable to enter or leave the US. Expenditures are made by a government sector, a representative consumer, the industries, and the rest of the world through imports and exports.

We perform a series regression to determine the values of the parameters that define the relationships in the cost functions. These regressions have an endogeneity problem that must be dealt with since prices, a right hand side variable, are dependent on cost shares, a left hand side variable. Additionally, since the cost shares of all the inputs must sum to one, the error terms of the regressions are correlated. We deal with both of these problems by performing the regressions via iterated three-stage least squares.

The data used in the regressions and simulation come from several sources. The first is a system of U.S. national accounts covering the years 1960 to 2005 compiled by Jorgenson (2007). 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.

In order to model the proposed changes in the budget, we have to model each proposal within the context of the general equilibrium model. For example, although crude from oil sands are not taxed under current law, they would be under the budget proposal. However, modeling the choices firms have to produce products from different types of crude oil is a level of detail too great for this general equilibrium model. Simplification of the tax proposal is needed to make it tractable. For this reason, we model the proposed budget in the following manner. The average yearly JCT revenue estimate of the budget proposals discussed is taken and divided by the value of output of fossil fuel producing sectors to get the ad valorem excise tax rate necessary to generate this amount of revenue. This ad valorum excise tax on fossil fuel producing sectors is what is then simulated in the model. Thus this simulation does not attempt to evaluate the effects of the individual features of the budget proposal. Analysis of the desirability of those changes is only covered by Section II. This analysis instead looks at the effects of the aggregate tax increases on fossil fuel production that would come about as a result of all the changes proposed by the budget.

Additionally, in order to determine the effects of a policy, it must be compared to the state of the economy under an alternative policy. One alternative is current law tax rates. But using that as an alternative would require additional assumptions about the tradeoff between immediate tax increases and debt finance. To simplify the comparison, we instead compare the president's fiscal year 2013 budget proposal to a policy of raising the same amount of revenue through an ad valorem excise tax on all sectors at a uniform rate.

IV.B. Model Results

Figure 1 shows the increase in the price of each sector's output that would occur under the budget proposal. There is a large increase in price for the fossil fuel producing sectors. The largest price increase of 2.7 percent occurs for Petroleum and coal manufacturing while pipeline transportation and oil and gas mining have price increases of 1.8 percent. Sectors which heavily rely on fossil fuels such as transportation, utilities, and mining have smaller price increases on the order of 0.1 to 0.3 percent. Other sectors typical have negligible changes in the price of their goods.

Figure 1: Price Increase From the Budget Proposal by Sector

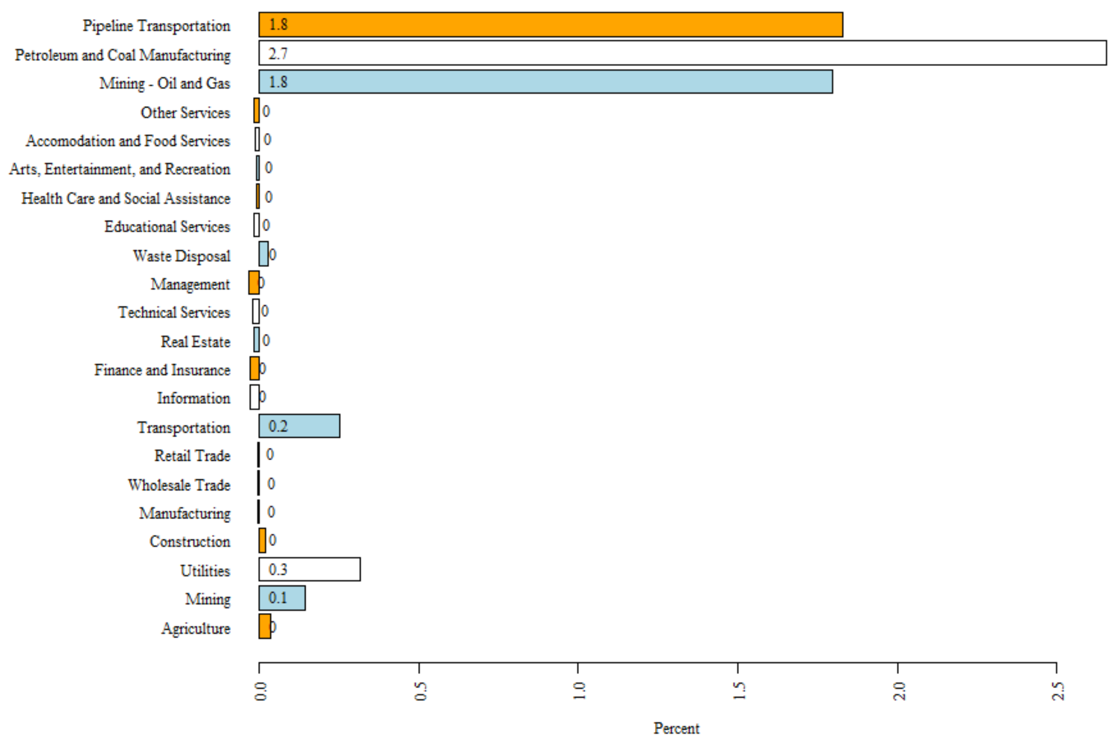


Figure 2 shows the decrease in the output of each sector that would occur under the budget proposal. As for prices, the largest decrease in output occurs in fossil fuel producing sectors. However, there is much more variance here. Output in pipeline transportation decreases by 1.7 percent but petroleum and coal manufacturing output only falls 0.5 percent. We again see smaller declines for sectors reliant on fossil fuels. Output in utilities falls 0.3 percent and transportation falls 0.2 percent.

Figure 2: Output Decrease From the Budget Proposal by Sector

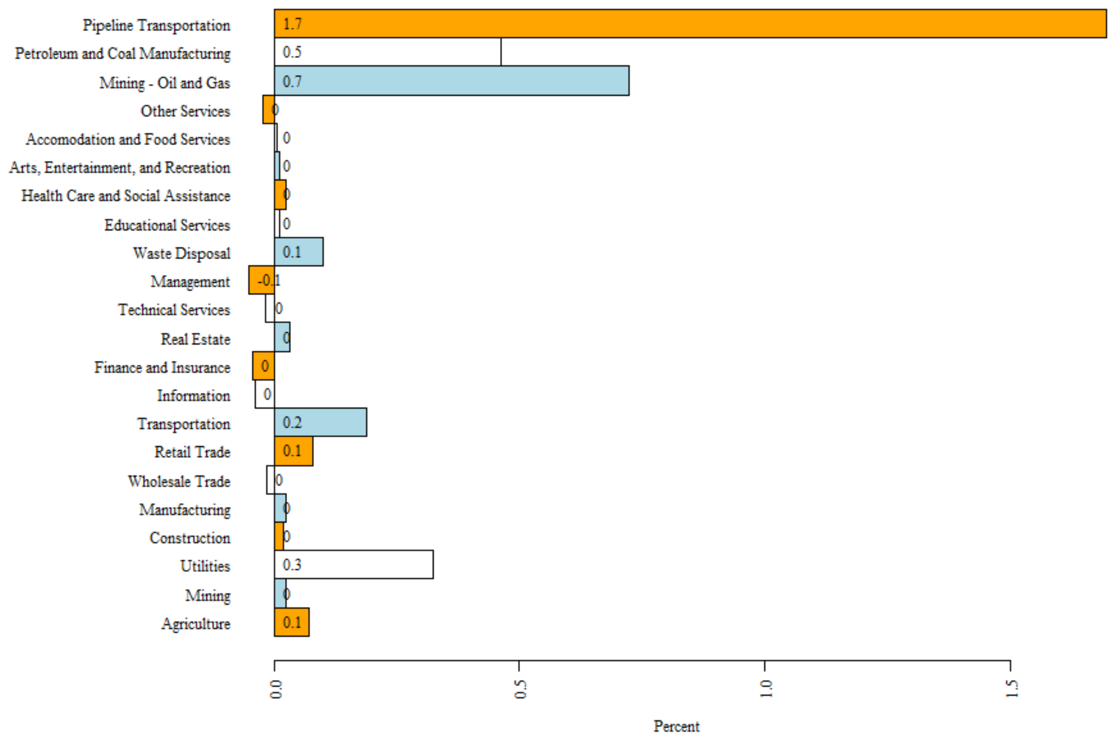
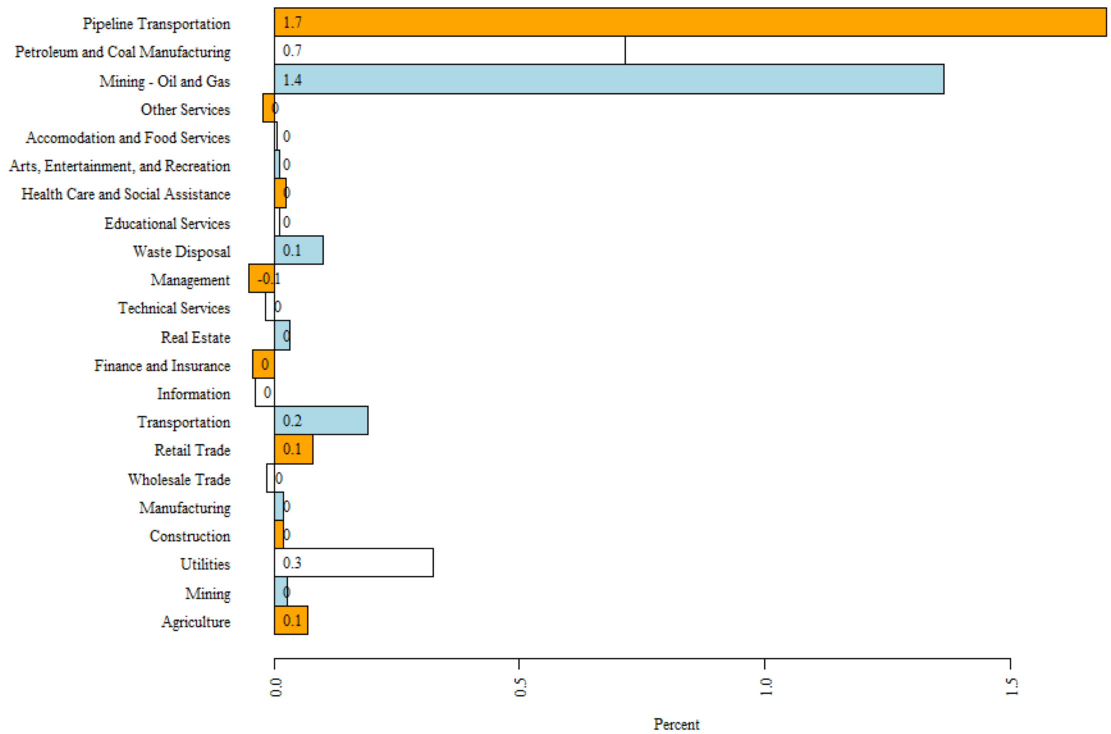


Figure 3 shows the decrease in demand for each sector's goods that would occur under the budget proposal.[29] Again, fossil fuel producing sectors see the largest decrease in demand. Demand for pipeline transportation decreases by 1.7 percent while demand for petroleum and coal manufacturing falls the least among fossil fuels with a 0.5 percent decrease. As before, demand for the output of sectors reliant on fossil fuels also falls. Demand for utilities falls 0.3 percent and transportation demand falls 0.2 percent.

Our methodology also allows us compare the excess burden of revenue raised under the budget proposal to the alternative uniform ad valorem excise tax. We calculate the equivalent variation consumers would be willing to pay if they were under the baseline specification of a uniform tax increase to avoid changing to a regime where the tax increase was focused on fossil fuels. We then divide the equivalent variation by the revenue raised by the budget proposal. We find that revenue raised under the budget proposal has an excess burden that is higher by 60 percent of revenues compared to raising the same amount of revenue under a uniform ad valorem excise tax.

[29] We define demand as domestic production plus imports, or equivalently, output minus exports.

Figure 3: Demand Decrease From the Budget Proposal by Sector



Finally this leads us to the per ton cost of carbon dioxide emission reductions. The budget proposal will reduce demand for fossil fuels more than the baseline tax increase but at the cost a higher excess burden for consumers. If we make the assumption that the percentage reduction in total US carbon dioxide emissions is less than or equal to the largest reduction in demand faced by an energy sector (1.7 % for pipeline transportation), we can calculate a lower bound for the cost per metric ton of carbon dioxide reduction from this budget proposal. We multiply the excess burden rate by the average yearly JCT revenue estimates to get the total cost of pollution reduction. We then divide this value by 1.7% times the total US carbon dioxide emissions to get the cost per metric ton.[30] This gives the cost of carbon dioxide reduction from the proposal a lower bound of $69 per metric ton. Therefore in order for the budget proposal to be justified on the basis of reducing carbon dioxide emissions, the cost of alternative sources of abatement and the cost of damages caused by carbon dioxide emissions must exceed $69 per metric ton.

IV.C. Interpreting the Results

All models are based on assumptions about the structure of the market and behavior of its participants. When interpreting the results of a model, it is important to consider how the results would change if different assumptions were made instead. In this section, we identify several key assumptions of the model and describe exactly how our results would

[30] Total US greenhouse gas emissions in metric tons of carbon dioxide equivalents are taken from the 2011 value in Table ES-2 in http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2011.pdf.

change if different assumptions were used instead. Although we can't give the exact magnitude of the changes, we are able to sign the direction in which they would change our estimates and thus describe whether the estimate is an upper or lower bound on the true value.

In the model the total amount spent on imports and exports is assumed to be constant regardless of policy and it is also assumed that the price of imports and exports will increase or decrease with the domestic price of the good. However, in reality, we would expect consumers to respond to the increase in the price of domestic fossil fuels by importing more and exporting less. Allowing quantity imported to rise and exports to fall in response to the budget proposal being implemented would increase the drop in domestic production of fossil fuels but reduce the drop in domestic consumption of fossil fuels and also reduce the domestic price increase. A lower drop in domestic consumption would increase the per ton cost of carbon reduction.

The budget's net tax increase is modeled as imposing an ad valorum excise tax on fossil fuel producing sectors. However, the budget proposal is not actually entirely composed of excise tax increases. It is composed of some (although not ad valorum) excise tax increases but also reduced deductions for the corporate income tax, which raise the corporate income tax's effective rate. And the corporate income tax statutorily falls on returns to capital, not the total value of output like an excise tax. Replacing part of the excise tax increases with capital tax increases would more accurately model the proposed budget. But by moving part of the tax increase to one of the inputs for fossil fuel production, we increase the ability of firms to substitute away from the tax increase by changing their input mix. This would decrease the price increase and quantity demand decrease caused by the tax, decrease the revenue raised by the tax, and increase the excess burden of the tax. This would also increase the per ton cost of carbon reduction.

Finally, the only tax included in the model is the ad valorum excise tax from the proposed budget. Revenues from other pre-existing taxes are not included in the model. This means the estimated change in revenue resulting from the proposed budget does not include the changes in revenue due to reduced or increased collections from these other taxes. However the drop in demand is concentrated in fossil fuel production and the results in Section III state that the average tax rates for fossil fuel production are higher than other sectors. This implies that if the revenues of these other taxes were included, total revenues in the proposed budget would fall relative to the alternative case were the revenue is raised by spreading the ad valorum excise tax over all sectors. This would also increase the per ton cost of carbon reduction.

To summarize, the combined effect of these assumptions means the model provides an upper bound on the price increase, the revenues of the budget proposal, and the decrease in domestic demand. It provides a lower bound on the excess burden of the revenue raised by the proposal and the cost of carbon dioxide emission reductions.

V. CONCLUSIONS

The proposals in the president's fiscal year 2013 budget to increase the Oil Spill Liability Trust Fund excise tax rate, target the domestic manufacturing deduction, modify the dual capacity rules, and reinstate the Superfund excise taxes reduce the neutrality of the tax code. The proposals to repeal the capital gains treatment of coal royalties and increase the G&G amortization period are neutrality enhancing. The neutrality of repealing LIFO, percentage depletion, and the expensing of IDCs and coal exploration is unclear.

Although some of the individual tax provisions identified for repeal in the President's 2013 Budget favor fossil fuel production, it is not clear that the tax code as a whole does. Previous studies calculating marginal effective tax rates on capital employed in fossil fuel production have had mixed results. Our calculations show the average effective tax rate on capital used in fossil fuel production is 2.9 percentage points higher than the economy wide rate. However these taxes are only a minority of taxes paid by the industry. Calculating average effective tax rates for all taxes on fossil fuel production gives a tax rate that is either 8.8 or 1.5 percentage points higher than the economy wide rate, depending on the basis used.

General equilibrium results indicate that the proposal will increase the price of fossil fuels by 1.8 to 2.7 percent, decrease their output by 0.5 to 1.7 percent, and decrease their demand by 0.7 to 1.7 percent. The excess burden of the additional revenue gained is an additional 60 percent of revenues higher than if the tax increase were applied uniformly across all sectors. The cost of the carbon dioxide reduction due to the proposal is at least $69 per ton.

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Appendix A: Cost Function

In the model, there is not a single cost function for an entire 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 4. 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 good, but a basket of goods created from inputs which, at the lowest level, are all 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

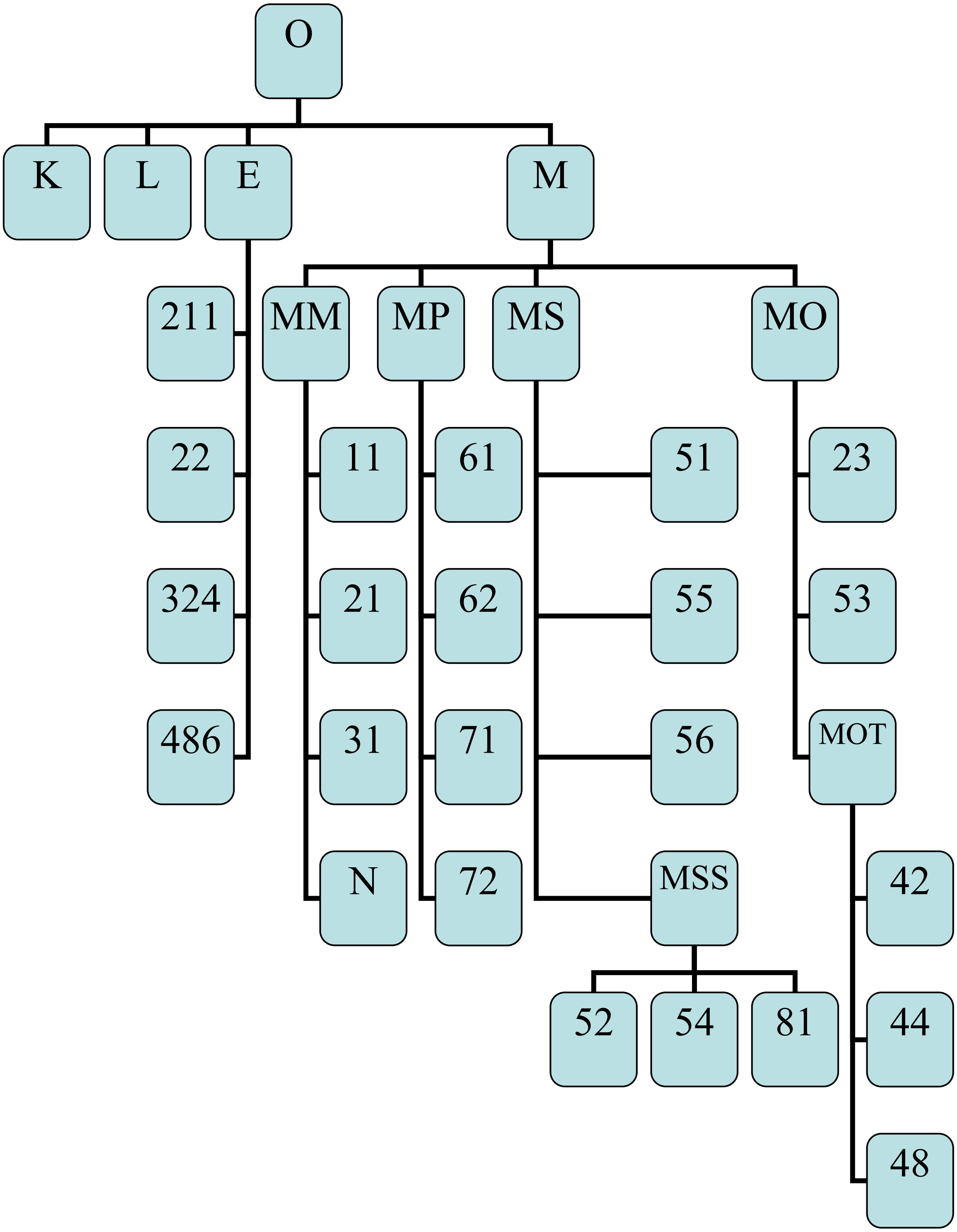
$$\ln\left(c_{xt}\right) = \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N}\beta_{ij}^{substitution}\ln\left(p_{it}\right)\ln\left(p_{jt}\right) + \sum_{i=1}^{N}\beta_{i}^{shareconstant}\ln\left(p_{it}\right)$$

$$+\sum_{i=1}^{N}\beta_{i}^{sharetrend}\ln\left(p_{it}\right)t + \beta^{costtrend}t + \beta^{constant}$$

where $\ln\left(c_{xt}\right)$, the log cost of producing commodity *x* at time *t*, is a function of the log input prices $\ln\left(p_{it}\right)$ of the N inputs indexed by industry *i* and the year *t.* [31] [32] The variables $\beta_{ij}^{substitution}$, $\beta_{i}^{shareconstant}$, $\beta_{i}^{sharetrend}$, $\beta^{costtrend}$, and $\beta^{costconstant}$ for the inputs *i* and *j* are the 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*. $\beta_{i}^{shareconstant}$ is an intercept that gives the value share of input *i* at this 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 $\ln\left(c_{xt}\right)$ and multiplying by the statutory tax rate. For lower nodes, their price is equal to their cost.

[31] We omit the variable 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.
[32] The value of N, the number of inputs used to make a commodity, ranges from one to four and is defined for a particular node according to Figure 4. It varies across nodes but is the same at any particular node across industries.

Figure 4: 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.