A New Approach to Estimate the Incidence of the Corporate Income Tax

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Abstract

After Harberger published his influential paper in 1962, many authors have assessed empirically whether the incidence of the corporate income tax (CIT) falls on capital owners, consumers, or workers (Krzyzaniak and Musgrave, 1963; Gordon, 1967; Arulampalam, Maffini, and Devereux, 2008). Today, there is little agreement among economists about who bears the incidence of the CIT (Gruber, 2007; Harberger, 2008a,b). The reason for the little convincing evidence is that the econometric models used in the literature ignore that the factors that motivate changes in corporate tax policy are sometimes correlated with other developments in the economy and disentangling those effects from exogenous policy changes requires tremendous effort.

Using annual information at the industry level for the United States, I propose to investigate the consequences of exogenous changes in corporate tax policy. The identification of these exogenous events follows the work of Romer and Romer (2009, 2010), who provide an extensive analysis of the U.S. federal tax legislation using narrative records from presidential speeches and congressional reports, among other documentations. The results validate the original predictions from Harberger (1995, 2008a). That is, in the short-term, capital owners bear the full burden of the tax. Over time, however, capital owners are able to shift this burden either by raising consumers' goods prices, or decreasing workers' wages. The magnitude of these effects depends on the degree of capital intensity as well as the access to international markets and the availability of substitutes for the industry under consideration.

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1 Motivation

"Only People—Not Goods or Organizations—Can Bear the Burden of a Tax."

After Harberger published his influential paper in 1962, many authors have assessed empirically whether the incidence of the corporate income tax (henceforth CIT) falls on capital owners, consumers, or workers (Krzyzaniak and Musgrave, 1963; Gordon, 1967; Arulampalam, Maffini, and Devereux, 2008).[1] Even today, there is no agreement among economists about who bears the incidence of the CIT (Gruber, 2007; Harberger, 2008a,b). The reason for the little convincing evidence on who bears the burden of this tax is that the econometric models used in the literature are not able to account for the different reasons that motivate corporate tax changes. That is, the factors that motivate changes in corporate tax policy are sometimes correlated with other developments in the economy—e.g., financing healthcare reform, and disentangling those effects from exogenous policy changes requires tremendous effort. In addition, all previous empirical studies are based on a single-point estimate, or short-run elasticity, of the effect of a tax change on the price of consumer goods and the price of production factors: labor and capital, neglecting the issue of timing. Thus, the empirical literature thus far has ignored that the incidence of a change in the CIT, as predicted in Harberger's model, occurs over time—as investors move some part of the capital stock immediately and other part gradually (see Auerbach, 2006, p. 10). Therefore the effect of the CIT on prices will also depend on the short- and long-term ability of capital owners to escape taxation.

To consider an example on how the dynamics of corporate tax changes might work,

[1]Before advancing any further, it is important to clarify a few concepts. Economists use tax incidence analysis to identify how the burden of a tax is distributed across individuals. In this sense, the literature identifies two incidence measures: (i) statutory incidence, which measures incidence in terms of who actually paid—i.e., according to the law—the tax; and (ii) economic incidence, that considers the combined effect of statutory incidence and how real income responds to changes in goods and factor prices when a tax is imposed. These two measures will differ in the presence of tax shifting. Tax shifting occurs whenever some individuals—e.g., in this case corporations–can transfer the burden of the taxes they are supposed to pay, through changes in factor rewards and prices (Bruce, 2001, p. 325-26). This study focuses on the economic incidence—henceforth referred only as incidence—of the corporate income tax, unless otherwise specified.

suppose that the U.S. government decides to impose a tax on the income from oil extracting companies to cover for potential environmental damages—e.g., an offshore platform could explode in the Gulf of Mexico spilling thousands of barrels of oil into the sea. The initial, or short-term, effect of the tax will be to reduce the profits of oil corporations, harming corporations' owners and stockholders. Over time, as oil extraction becomes less profitable, investors move their capital to other sectors, or countries, where they can obtain a higher return, thus escaping the tax. As less capital is available to build new oil rigs, the industry's supply of oil and demand for workers decline. Therefore, in the long-term, the CIT would result in higher gas prices and lower wages—affecting consumers and workers, economy-wide.

The previous example summarizes the intuition behind Harberger's contribution. Nevertheless, a set of assumptions about production functions and the elasticities of product demands and factor substitutions are required in order to determine the *true* incidence of the CIT. Following this path, general equilibrium (GE) models have been developed since the 1980's, in which economists simulate the tax-expenditure system of a real economy (or group of economies) to analyze how policy changes affect individuals' income and welfare. However, as Harberger indicates, the modeling and calibration to the economy analyzed "must be of high quality," and given the disagreement about the main parameters that must be chosen, this constitutes a challenging task. Moreover, these models might not be measuring only the incidence of the CIT, but that of the "entire tax system," making the incidence analysis unintelligible (Harberger, 2008a, p. 285-86). As of today, the general equilibrium modeling literature is inconclusive regarding who bears the incidence of the corporate income tax.[2]

The importance of determining the incidence of the CIT is twofold. For equity consid-

[2]To cite few examples, Gravelle and Smetters (2006) use an open economy general equilibrium model, calibrated for the U.S. economy and the rest of the world, and claim that capital owners bears the full burden of the CIT. In Harberger's view, however, some of the "key" parameters used for the calibration are "quite implausible" (Harberger, 2008a, p. 306). On the other hand, Gentry (2007) conducted a review of the open economy general equilibrium model literature and concludes that labor and land—as immobile factors—bear the burden of this tax.

erations, the assumptions on the incidence of the corporate tax have crucial implications when policy makers evaluate the progressivity of the tax system. For instance, in a 2007 report entitled "Historical Effective Federal Tax Rates: 1979 to 2005," the Congressional Budget Office (CBO) showed that the corporate income tax—and the U.S. tax system overall—is moderately progressive. However these calculations rely on the assumption that "corporate income taxes are borne [fully] by owners of capital" (CBO, 2007, p. 3). Thus, in the opposite case that the burden of the CIT is borne by consumers or workers, the CBO's conclusions will imply a misunderstanding or overstatement of the progressivity of the national tax system.[3]

On efficiency grounds, the CIT always occupies an important place when policy makers are discussing the introduction of a tax reform. For instance, in a recent article Michael Boskin points to the role the CIT has in promoting efficiency and economic growth: "reducing or eliminating the corporate tax would curtail numerous wasteful tax distortions, boost growth in both the short and long run, increase America's global competitiveness, and raise future wages" (Boskin, 2010). Yet this assertion supposes that for an open economy with free mobility of capital, the CIT might reduce the reward for investments, and its long-term incidence is borne by workers. Kotlikoff and Miao (2010) investigate how the corporate income tax affects the level of business risk in the economy. In this model, entrepreneurs can choose to declare their firms as one of two types: (i) corporate and (ii) private. The former are allowed to trade publicly in capital markets, while for the later public trading is banned. The access to capital markets permits corporate firms to diversify their asset portfolio, thus reducing their level of risk. However, these corporations are subject to the CIT.[4] Using a simple model in which production depends on

[3]The CBO argument about the progressivity of the CIT is based on estimations of effective tax rates—the ratio of tax liability to income—for each quintile of the income distribution of the population. According to these calculations, in 2005 the lowest quintile of the income distribution has an effective tax rate of 0.4%. This rate increases progressively to 0.5% for the second, 0.7% for the middle, 1.0% for the fourth, and 4.9% for the highest quintile of the income distribution (see CBO, 2007, Table 1).

[4]The U.S. tax code makes a similar distinction when classifies corporations as "C-corporations" and "S-corporations"—the letters "C" and "S" refer to the corresponding chapters in this legislation. The profits from C-corporations are subject to the corporate income tax. Moreover, dividends from C-corporations are taxed at the individual level when they are distributed to investors. On the other hand, S-corporations

labor and managerial skills, they show that the CIT reduces the amount of publicly traded companies on behalf of private entities thus increasing the level of risk in the economy.

To empirically determine the incidence of the CIT (and perhaps the reason why previous attempts might have failed), it is necessary to obtain time series information on exogenous changes in policy that allows for the estimation of the short- and long-term effects of tax changes on the price of goods and services produced as well as the price of production factors: rate of return on capital and wage rate. In the words of Harberger (2008a), however, this could be a challenging task given that "the world never gives us a clear incidence scenario in which we can trace out the consequences of a tax change by simply following the data" (p. 305). Thus, the realization of this effort constitutes this research's major contribution.

I employ a new and better methodology that allows for improved analysis of how the incidence of the CIT is distributed over time among workers, consumers, and capital owners. Using annual information at the industry and firm level for the United States, I propose to investigate the consequences of exogenous changes in corporate tax policy. The identification of these exogenous events are based on the work of Romer and Romer (2009, 2010), who provide an extensive analysis of the U.S. federal tax legislation using narrative records from presidential speeches and congressional reports, among other documentations. That is, by looking at the sources that motivate tax policy changes, this study separates exogenous events in corporate tax policy from other developments within the economy and, therefore, it obtains a "clean" estimate of the incidence of the corporation income tax.

The estimation procedure is conducted by Vector Autoregressions (VAR) models. As section 3 explains, the advantages of using a VAR specification can be described as follows. First, the VAR specification assumes that all the variables in the system of equations are endogenous, thus solving the simultaneity problem that arise in the literature when es-

do not pay the CIT. Instead, their profits are taxed under the individual income tax when they are distributed among shareholders.

timating factor returns as functions of the CIT. Second, the impulse-response functions (IRF) obtained from the VAR system allow the analysis of the dynamic impact of exogenous shocks associated with corporate income tax policy. These dynamic responses tie the short and long run reactions of prices to policy changes in a smooth function that enhances the interpretation of the results.

The results validate the original predictions from Harberger (1995, 2008a,b) on the effect of an exogenous increase of the corporate income tax for a multi-sector open economy. That is, in the short-term, capital owners bear the full burden of the tax. Over time, however, capital owners are able to shift this burden either by raising consumers' goods prices, or decreasing workers' wages. The magnitude of these effects depend on the degree of capital intensity as well as the access to international markets and the availability of substitutes for the industry under consideration.

2 The Data

There are two major components that comprise this data set: prices and tax policy changes. For prices, I calculate and obtain information on the rate of return on corporate capital, the wage rate, and the prices of goods and services across eight major U.S. industries. The tax policy variable is based on the exogenous fiscal shocks in the corporate income tax recorded in Romer and Romer (2009, 2010). Other control variables are also included and they will be described below. The sample period for this study runs from 1945 to 2007 and the frequency is annual.

The industry classification is based on the Standard Industrial Classification (SIC) system for the years from 1945 to 1997, and the North American Industry Classification System (NAICS) from 1998 onwards. The information is compiled for eight major industries: (i) Agriculture, forestry, and fishery (henceforth referred to as Agriculture); (ii) Mining and quarrying (Mining); (iii) Construction; (iv) Manufacturing; (v) Public Utilities and Transportation (Utilities); (vi) Wholesale & Retail (Trade); (vii) Finance, insurance, real state and lessors of real property (Finance); and (viii) Services. In order

to make both classification systems comparables, it was necessary to "bridge" the series from the NAICS to the SIC system using data from the U.S. Census Bureau.[5]

2.1 Bridge from NAICS to SIC

In 1997, the chage from the SIC system to the new industrial classification system based on the NAICS considerably affected the comparability of the time series with those of prior years. Table 1 shows the major changes to the industrial classification as well as some of the adjustment employed to harmonize (or bridge) the NAICS series with the SIC series. With the introduction of the NAICS, the number of major industries, or 2-digit code industries, significantly expanded from eight sectors (column 1) to nineteen sectors (column 2). Therefore, it was necessary to bridge the new NAICS system to the prior 1997 SIC system in order to obtain a data set from 1945 to 2007 based only in one system: the SIC classification system (column 3). Also, whenever it was impossible to retrieve a NAICS subsector and add it back to the corresponding SIC sector, I created industry weights to make the proper adjustments. These weights were constructed using the ratio of the value of receipts for a particular subcategory to the total value of receipts of the 2-digit industry classification, reported in the 1997 Census.[6]

Table 1 explains the bridge process. While some major industries were not virtually affected with the switch from SIC to NAICS—e.g., Agriculture and Mining, particular care should be taken comparing industries such as Manufacturing, Transportation & Utilities, and Services, among others, which are sectors with similar titles in both NAICS and SIC, but composed of different sub-sectors. For instance, table 1 shows that the Agriculture sector was unafected after the introduction of the NAICS system. The Mining sector, titled "Mineral Industries" in the SIC, only required a minor change with the NAICS system, because it now excludes part of industries classified under the Professional, Sci-

[5]The methodology to construct the bridge between NAICS and SIC is fully explained in the U.S. Census Bureau's website (see Census, 1997) as well as in section 5 of the 1998 SOI report (IRS, 1998).

[6]The total value of receipts includes "the total sales, shipments, receipts, revenue, or business done by establishments within the scope of the economic census," Census (1997).

Table 1: Bridge Between NAICS and SIC: 1945 - 2007

1987 SIC (8 Industries: prior 1997)	**1997 NAICS** (19 Industries: 1997-onwards)	**Bridge: NAIC to SIC** (8 Industries: 1997-onwards)
1. Agriculture	1. Agriculture	1. Agriculture
2. Mineral Industries	2. Mining	2. Mining Mining from NAICS +0.1% of Prof. Scientific & Tech
3. Manufacturing	3. Manufacturing	3. Manufacturing Manufacturing from NAICS +Publishing Industries (Inform.) +0.3% of Other Services
4. Transp., Communic., and Utilities ... ⋮ 8. Service Industries	4. Transp. & Warehousing 5. Utilities 6. Adm. & Support 7. Information ... ⋮ 19. Other Services	4. Transp., Communic., and Utilities Transp. & Warehousing (NAICS) + Utilities + Waste Manag. (Adm. & Support) + Telecommunications (Inform.) + ... ⋮ 8. Service Industries

entific and Technology Services sector: geophysical surveying and mapping services for metal mining, oil and gas extractions, and non metallic mineral mining. These three subcategories, not reported in the SOI tables, represent 0.1% of the total receipts in Professional, Scientific and Technology Services.

To build the Manufacturing sector series based on the SIC system, I took the new Manufacturing series from the NAICS system and added the "Publishing Industries" subcategory, which under the NAICS is part of the new 2-level digit code "Information" industry. I also added 0.3% of the "Other Services" industry to account for data from auxiliary establishments not included with the manufacturing data. Similar adjustments were performed until the bridge between NAICS and SIC was completed for all sectors.

2.2 Tax policy variable: Romer & Romer shocks

Romer and Romer (2009, 2010) analyze more than fivety tax reforms, from 1945 to 2007, and classified all tax policy changes for the post war era in four major categories attending their motivation: (i) spending-driven, (ii) countercyclical, (iii) deficit-driven, and (iv) long-run growth. The spending-driven tax change are motivated by changes in government spending—e.g., raise taxes to finance a war, while countercyclical tax policy changes intend to return output to its normal trend—e.g., a tax cut to fight a recession. Both of these actions are considered as "endogenous tax changes." On the other hand, deficit driven actions are taken to tackle a current government deficit, while long-run tax policy changes are intended to promote economic growth as well as efficiency and fairness in the tax system. These later two policy actions are classified as "exogenous tax changes."[7]

To illustrate the Romer and Romer (2009, 2010) procedure, let's consider four policy changes, each corresponding to one of the motivations defined above:[8]

- **Revenue Act of 1950**. The motivation for this policy was to raise taxes to cover for defense spending related to the Korean War. This tax policy took the form of increases of marginal tax rates on individuals and corporations. In the *Letter to Committee Chairmen on Taxation of Excess Profits*, President Truman stated:

  > "After the communist aggression in Korea last summer, the Congress recognized the need for greatly increasing the Government's revenues to meet the grave dangers that confront our country" (p. 1).

  Similar statements appeared repeatedly in the *Midyear Economic Report of the President* for 1950, the *Congressional Record* (1950), among a number of Senate reports and documents. For this reason, this policy is classified as "endogenous spending-driven."

[7] For details on these concepts, also refer to Romer and Romer (2009, p. 5-6).
[8] See Romer and Romer (2009) for extensive details.

- **Public Law 89-800.** Enacted on September of 1966, this policy suspended the 7% investment tax credit and its motivation was to return output to its normal trend. When addressed the Congress for the introduction of this reform, President Johnson recommended:

  > "the Congress promptly make inoperative,..., those special incentives for plant and equipment investment and commercial construction that currently contribute to overheating the economy" (Special Message to the Congress on Fiscal Policy, 1966, p.1).

  Among the reports that presented similar statements were 1967 and 1968 *Economic Report of the President*, the 1967 *Annual Report of the Secretary of the Treasury on the State of the Finances*, and a number of Congressional reports. Thus, this policy change is classified as "endogenous countercyclical."

- **Revenue Act of 1971.** The 1972 *Economic Report of the President* suggested that policy makers were concerned about promoting economic growth beyond its long-term trend: "The economy was rising...; but the rise was not as fast as was desirable, especially from the standpoint of reducing unemployment" (p. 65). For this reason, the President introduced the Revenue Act of 1971 to promote growth above normal:

  > "The fiscal package... was primarily motivated by the desired to stimulate at once a more rapid expansion of the economy" (p. 69).

  If there is not a consistent and systematic review of the documents that policy makers use to introduce the reform, Romer and Romer (2009) recognizes that this methodology might lead to wrong conclusions when classifying fiscal policy. For instance, the House of Representatives indicated that "this bill is necessary because the performance of the economy in recent months has been unsatisfactory,"[9] which

[9] 92^d Congress, 1^{st} Session, House of Representative Report No. 92-533, 9/29/71, p.3.

suggests that "Congress... might be acting to merely return growth to normal" (Romer and Romer, 2009, p. 55), thus indicating that this policy could be classified as "endogenous countercyclical." However, the review of additional documents, such as The Ways and Means Committee reports, among others, indicates that this policy can be classified as "exogenous long-run growth."

- **Fiscal Responsibility Act of 1982.** This reform proposed the reduction of tax benefits from the Investment Tax Credit. President Reagan clearly stated the motivation for this policy in his 1982 Address to the Nation on the Fiscal Year 1983 Federal Budget:

  > "The most essential thing is to send a message to the money market that we,..., can agree on reducing the deficit" (p. 3)

  The U.S. Congress was more energetic than the president to recognize the need to reduce the fiscal deficit when it declared that the reason for this bill was "to raise revenue as part of an effort to narrow the *unacceptably* large budget deficits..." (emphasis are mine).[10] For those reasons, this policy is classified as "endogenous deficit-driven."

Based on Romer and Romer (2009, 2010) classification method, I identified twenty exogenous policy changes in the corporate income tax for the period from 1945 to 2007. Figure 1 plots the rate of return of corporate capital in the Manufacturing sector and the exogenous policy changes in the CIT from Romer and Romer (2009). These policy changes are separate into seven exogenous increases in the corporate income tax (top panel), and thirteen exogenous decreases (bottom panel).

The exogenous changes in the CIT, in figure 1, are recoded into an indicator variable $\mathbf{D_t}$ that identifies the dates in which these shocks occurred. That is, for the exogenous policy changes that increased the CIT in the 1945-2007 period, $\mathbf{D_t^i} = 1$ if $t =$[1976, 1982,

[10] 97^{th} Congress, 2^d Session, Senate Report No. 97-494, Vol. 1, 7/12/82, p.96.

1984, 1986, 1987, 1993, 2004], and 0 otherwise. For the exogenous decreases, then $\mathbf{D_t^d} = 1$ if t =[1953, 1954, 1962, 1964, 1967, 1970, 1971, 1978, 1981, 1982, 1983, 1987, 2003], and 0 otherwise.

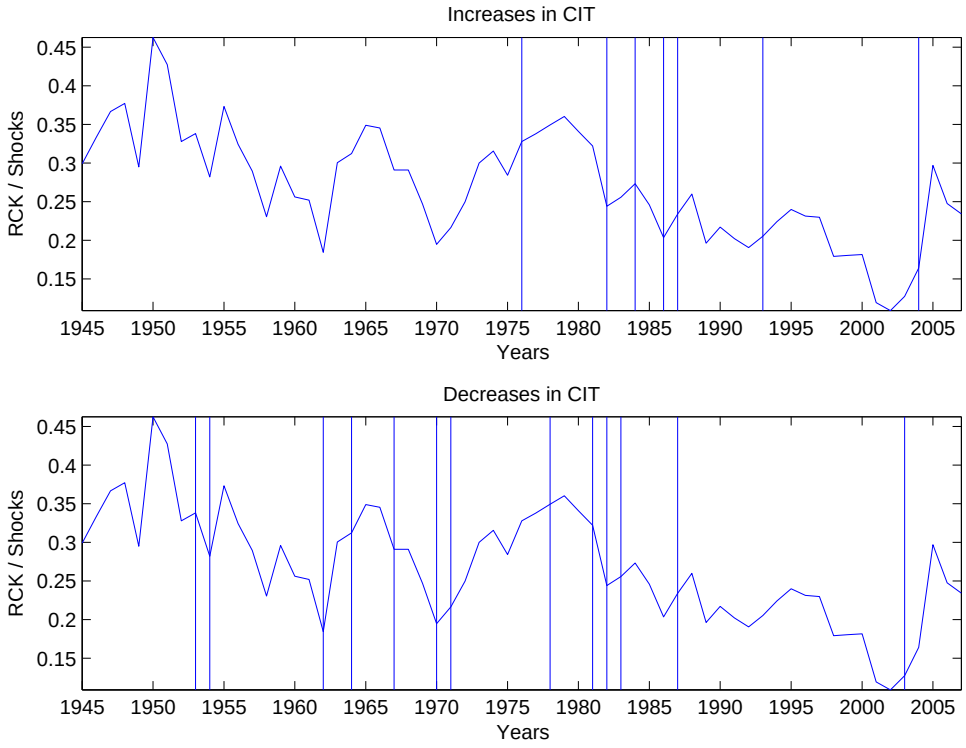

Figure 1: Retun to corporate capital in Manufacturing and exogenous policy changes in the corporate income tax (CIT), 1945-2007.

2.3 Return to corporate capital and tax rates

I use information from the Statistics of Income (SOI) annual reports, published by the U.S. Department of the Treasury's Internal Revenue Service (IRS), to estimate the rate of return of corporate capital and a measure for the tax rate. These reports contain information on the balance sheets and income statements at the industry level for the United States. The IRS uses a probability sample as the basis of the data tabulated from corporate returns. The industries are classified under the SIC system for the period from

1945 to 1997 and the NAICS system for the 1998-2007 period, therefore it was necessary to bridge the industry level series using the methodology explained in sub-section 2.1.[11]

The return on corporate capital for industry i at time t is calculated as the ratio of corporate profits (π) to the corporation's capital stock (K):

$$RCK_{it} = \frac{\pi_{it}}{K_{it}}, \quad \text{for} \quad i = 1, ..., 8 \quad \text{and} \quad t = 1945, ..., 2007; \tag{1}$$

where profits are defined as the sum of net income—i.e., the difference between total income and total deductions reported—plus interest paid.[12] The capital stock is composed of equity capital, which includes both common and preferred stocks, and the interest bearing debt (IBD)—the total amount of bonds, notes, and mortgages payable maturing in the short and long term. The measure of return on corporate capital in (1) was applied in other studies addressing the question of the incidence of the CIT (see Krzyzaniak and Musgrave, 1963; Cragg et al., 1967) as well as in studies from the finance literature that employ accounting-based measures of operating performance (see Barber and Lyon, 1996; Ghosh, 2001).

However, a number of authors used a different slightly modify equation (1) to measure the effect of corporate tax changes on the return to corporate capital. For instance, Krzyzaniak and Musgrave (1963) subtract the IBD component from the denominator—which gives a measure of the return on equity capital, or ROE, while Dusansky (1972) substitutes this denominator for total assets, obtaining a measure for the return on assets, or ROA. Gordon (1967) employs a similar version of (1) but introduces a cash-flow measure of profits, i.e., adding to the numerator other expenses such as depreciation, amortization, and depletion. To test for consistency, I employ the measure of RCK_{it} defined in 1 and compare the results with those using the ROA, ROE, and cash-flow measures defined

[11]For tax year 2007—which includes the accounting periods ending July 2007 through June 2008, the SOI's statistical estimates are based on a stratified sample of approximately 106,000 unaudited reports selected from 5.9 million corporate returns filed (IRS, 2007).

[12]Total income (or receipts) includes, but it is not limited to, gross sales, gross receipts from operations, interest received on government obligations, and so on. Total deductions consist of cost of goods sold, cost of operations, depreciation, amortization, among other components. For more details, see the annexed balance sheet and income statement from the SOI (2007) in the appendix.

above. I also constructed an additional measure for the return to capital using data from the Bureau of Economic Analysis (BEA) and I did not find any significant difference in the estimated impulse response functions.[13]

I also calculate and obtain two alternative measures of corporate tax rates: the average tax rate, ATR_{it}, and the nominal statutory tax rate, $NSTR_t$. The former is calculated as the ratio of total tax liabilities, or simply tax paid, to corporate profits for a particular industry i at time t.[14] The latter refers to the federal tax rate legally imposed on corporations. Both ATR_{it} and $NSTR_t$ are based on information from the SOI reports.[15]

2.4 Wages and prices

The measure of wages W_{it}^1 is taken from estimates of average weekly earnings of production and nonsupervisory employees, produced by the Bureau of Labor Statistics (BLS)'s Current Employment Survey (CES). This survey offers information on employment, payroll, and hours worked in a monthly basis. Thus, the annual estimates are obtained multiplying by 52 the 12-months monthly averages. Alternatively, I employ information on employees' total compensation and wages and salary accruals at the industry level published by the BEA, W_{it}^2. Total compensation for employees consist of wages and salaries plus employers' contributions to social security, pension, and health insurance funds.

The data on prices for goods and services correspond to information on consumer P_{it}^c and producer P_{it}^p price indexes, also produced by the BLS. The data is published monthly for a set of industries (e.g., Mining, Manufacturing, Utilities, etc.) and commodities (e.g.,oil and chemical products). Thus, I took 12-months averages as annual estimates.

The measures for prices and wages described above were applied before to analyze the

[13]From the BEA, I take the ratio of profits before taxes (NIPA Table 6-17) to private fixed assets (NIPA Table 3.1ES) as a measure for the return to corporate capital on each major industry. This data also required to bridge the NAICS and SIC series.

[14]As a result of the Korean War, the U.S. Congress imposed an excess profits tax—i.e., a tax on profits over a certain level, effective from 1 July 1950 to 31 December 1953. The SOI reports separates the excess profits tax from the total tax paid category, but I combined both categories in order to obtain the total tax liability for the 1950-1953 period.

[15]See the appendix for a comprehensive list of measures applied in this literature for the rate of return on corporate capital and the tax rate.

incidence of the CIT on consumers and workers (Sebold, 1979; Hassett and Mathur, 2006). Alternative measures for wages and prices can also be obtained from the corporation's balance sheets and income statements. For instance, Arulampalam et al. (2008) and Dye (1998) used the ratio between the cost of employees to the number of employees and the ratio of corporate profits to total sales as measures for the industry (or company) average wages and prices, respectively. These later measures are not considered here.

3 Modeling and Estimation Approach

3.1 Modeling approach

This section models the effect of the corporate income tax for a large and open multi-sector economy. The approach extends Harberger (1995, 2008a)'s four sector economy and also follows very closely the General Equilibrium models of Gravelle and Smetters (2006) and Randolph (2006).

There is a large open economy (e.g., United States) which freely trades with the rest of the world (ROW). The economy is divided into eight sectors, each producing goods and services using labor, capital, and land (in Agriculture). The supply of these factors is fixed in the economy. The production functions have constant return to scale and are well behave (i.e., concave, twice differentiable, etc.). There is free mobility of factor of productions, but only capital is mobile worldwide. There are eight sectors in the economy producing goods and services of which only two are non-corporate (Agriculture and Services), six are corporate, and four are tradables: two with perfect demand substitutes and two with imperfect substitutes.

The Mining sector (Corporate) produces tradables and perfect substitute goods—e.g., gold, iron, zinc, etc.—for which its price is determined at international markets. To simplify the analysis, it is standard in the literature to consider the production from a sector with these characteristics as the numeraire. Therefore, the price formation equation

for Mining is given by:

$$\delta p_{MG} = 0 = \theta_{L,MG}\delta w + \theta_{K,MG}(\delta r + t_{CK}) \tag{2}$$

where, δp_{MG}, δw, δr are the changes in the price for mining products, in the wage rate, and in the return to corporate capital, respectively. t_{CK} is the tax on corporate capital and the term in parenthesis $(\delta r + t_{CK})$ represents the cost of corporate capital, or C_k. The parameters $\theta_{L,MG}$ and $\theta_{K,MG}$ measure the income, or cost, shares of labor and capital for the mining sector, respectively. The price for mining products is fixed, $\delta p_{MG} = 0$, because it is determined worldwide.

The assumptions of perfect competition and free mobility of factors imply that the wage rate needs to decline economy-wide to absorve the higher cost of capital:

$$\delta w = -\frac{\theta_{K,MG}}{\theta_{L,MG}}(\delta r + t_{CK}) \tag{3}$$

Equation 3 says that the drop in wages depends on the degree of capital intensity of the Mining sector. That is, the larger the income share of capital in Mining $\theta_{K,MG}$, higher will be the drop in wages necessary to absorve the tax wedge created by t_{CK}. Table 2 shows estimates for the capital income shares across different industries. The table shows that the estimates for capital income shares are very stable across different time periods and industry classifications. My estimates of the capital income shares for U.S. industries (column 3) are very similar to those reported in Acemoglu and Guerrieri (2008) (column 2), which suggests that the capital income shares are very stable across different time periods and industry classifications. Since the share of capital income in Mining ($\theta_{K,MG} = 68\%$) is significantly higher than the share of labor income, the decline on the wage rate is expected to be large.

The Manufacturing and Finance sectors both produce tradable goods and services, respectively, that can be assume to be imperfect substitutes—perhaps given the technological advances in the U.S. economy compared to the ROW. Therefore, the price formation equation of these sectors will be:

$$\delta p_i = \theta_{L,i}\delta w + \theta_{K,i}(\delta r + t_{CK}) \tag{4}$$

Table 2: Industry Capital Shares

Industry (Based on SIC)	**Acemoglu (2008)**[1] (Averages for 1987-2005)	**Vasquez (2011)**[2] (Averages for 1945-2007)
1. Agriculture[3]	—	74%
2. Mining[3]	66%	68%
3. Transportation & Utilities	—	51%
Transport. & Warehousing	35%	—
Utilities	77%	—
4. Construction	32%	31%
5. Manufacturing	—	36%
Durable goods	27%	—
Nondurable goods	47%	—
6. Wholesale & Retail Trade	—	44%
Wholesale Trade	46%	—
Retail Trade	42%	—
7. Finance, Insurance, & Real Estate	—	75%
Finance & Insurance	45%	42%
8. Services[4]	33%	34%
9. All sectors	—	43%
Private sectors	—	47%

[1] Estimates based on the NAICS sytem. See Acemoglu & Guerrieri (2008), Table 1, pg. 486.

[2] Estimates based on the SIC system.

[3] The large magnitud in both Agriculture and Mining is explained by the land income share, which is part of the capital income share (see Valentinyi and Herrendorf, 2008).

[4] In Acemoglu & Guerrieri (2008) refers to "other services except government." In Vasquez-Ruiz (2011) refers to Services as classified in the SIC system.

for i = Manufacturing, Finance. For both sectors, the labor cost and capital cost will change by the same magnitud as the changes produced in the numeraire sector, e.g., Mining. That is, wages will decline with the tax, while the cost of corporate capital will rise. Thus, p_i will increase (or decrease) if the income share of capital in sector i is significantly larger than the share of income for labor, compared to the numerarie.

The other corporate sectors are Wholesale & Retail Trade, Construction, and Utilities & Transportation. They all produce non-tradable goods and services and, therefore, their prices will react according to equation 4. As in Harberger (1995, 2008a), I will expect that the price for the Utilities & Transportation sector will rise due to its large capital

income share.

The two non-corporate sectors are Agriculture and Services. The former produces tradable and perfect substitute goods, while the later only operates in the local market. Following Harberger (1995, 2008a), Agriculture produces using capital, labor, and land, therefore:

$$\delta p_{AG} = 0 = \theta_{L,AG}\delta w + \theta_{K,AG}\delta r + \theta_{Land}\delta l \tag{5}$$

where $\theta_{Land,AG}$ and l are the share of income to land and the land rent, respectively.[16] Equation 5 implies that land rent will change according to:

$$l = -(\frac{\theta_{L,AG}}{\theta_{Land}}\delta w + \frac{\theta_{K,AG}}{\theta_{Land}}\delta r) \tag{6}$$

As capital flows from the corporate to the non-corporate sector, its rate of return (r) declines. The wage rate also drops in Agriculture, according to equation 3 above. Therefore, the corporate income tax causes an increase in the land rent prices, thus benefiting landowners. Based on the same arguments, prices for the Services sector (non-corporate and non-tradable) will decline:

$$\delta p_S = \theta_{L,S}\delta w + \theta_{K,S}\delta r \tag{7}$$

3.2 Estimation procedure

The disagreements about who bears the burden of the CIT show that measuring the incidence of this tax is a challenging task. One of the reasons that could explain such significant differences in both results and opinions is that the econometric models used in this literature might not be adequately analyzing the effects of policy changes; for example, a change in the corporate income tax might be biased because the estimated parameters from these time series regressions are not invariant to the structural changes in the economy caused by policy making (Lucas, 1976, p. 20). That is, the parameter that supposedly determines the degree of corporate tax shifting might not only reflects

[16] Valentinyi and Herrendorf (2008) estimated the capital income share for Agriculture in 54%, of which 18% corresponds to land income share. They also present estimates for capital income shares in other sectors, including Manufacturing (33%) and Services (34%). See table 1, pg 826.

the effect of a change in the corporate tax but also the adaptation (or reaction) of corporations to the environment that could be motivating such policy change. Therefore, the conclusions derived from previous empirical models might be misleading.

In general, the factors that motivate CIT changes are often correlated with other developments in the economy, such as a decline in economic activity, and therefore separating these effects from exogenous policy changes can be very difficult. Moreover, the estimates of the incidence of the CIT based on time series regression models might reflect shocks to the private sector that are not the result of policy decisions. For instance, during the period considered, a shock might cause corporations to optimally change financing decisions to reduce tax liabilities—e.g., a switch from equity to debt financing, or corporations might simply decide to change pricing and hiring strategies in response to the economic situation.

Thus far, the econometric models and techniques used to estimate the incidence of the CIT have failed to separate those effects. For instance, the early time series studies of Krzyzaniak and Musgrave (1963), Gordon (1967), and Oakland (1972), among others, do not make any distinction between the corporate tax changes that results from policy decisions and the tax changes that results from endogenous economic events. More obviously, the results from these models seem to be very susceptible to the control variables included, as well as the sample period chosen. In addition, these studies claim to estimate the short-term incidence of the corporation tax based on the implausible assumption that the capital stock is immobile across sectors during the period under consideration—which in some cases is more than twenty years. The more recent empirical evidence, based on panel data estimations, also considers all changes in the tax variable as policy changes. Further, few authors attempted to offer short- and long-run estimates of the incidence of the CIT. However, this distinction is not always clear since the time period analyzed is no more than five or seven years (see Arulampalam et al., 2008).

To isolate the effects of policy changes from events occurring within the economy, a number of authors are using a new technique based on the identification of exogenous

events that alter fiscal policy through the examination of narrative records. For instance, Ramey and Shapiro (1998) use narrative records from historical accounts and *Business Week* and identify exogenous events leading to military build-ups to analyze the effects of government purchases in the economy—i.e., GDP, interest rates, hours worked, and consumption of durables and nondurable goods. Also, based on Ramey and Shapiro (1998) exogenous events, Edelberg et al. (1999) and Burnside et al. (2004) determine the effects of government purchases on on employment, real wages, and residential investment.[17]

More recently, Romer and Romer (2009, 2010) use narrative records from presidential speeches and congressional reports to identify tax policy changes that are not systematically correlated with developments within the economy during the postwar era. These authors provide a comprehensive analysis of more than 50 federal tax legislations in the United States for the period 1945-2007 and determine the effect of tax policy changes on U.S.'s economic activity—i.e., GDP, consumption, investment, and imports. The Romer and Romer (2009) exogenous events have been applied by a number of authors investigating the effect of fiscal policy on the U.S. economy. For instance, Merterns and Ravn (2011) develops a new narrative measure of exogenous tax changes using the changes in personal and corporate income tax identified in Romer and Romer (2009) plus controlling for measurement errors and present new estimates on the effect of tax policy on the economy. Also, Barro and Redlick (2011) use the narrative records from both Ramey (2009) and Romer and Romer (2009) to estimate government spending and tax multipliers.

I propose a similar approach to determine who bears the short- and long-term incidence of the corporate income tax. Specifically, using exogenous events in corporate tax policy, this paper analyzes the effects of corporate tax changes on the rate of return to capital, consumers' good prices, and wages. The identification of exogenous corporate tax changes is based on the work of Romer and Romer (2009), among other reports and documents. The estimation strategy employs a Vector Autoregression (VAR) model, as popularized

[17]The events referred to in Ramey and Shapiro (1998) are the Korean War (1950Q3), Vietnam War (1965Q1), and Carter-Reagan buildup (1980Q1).

by Sims (1980). This model provides a description of the dynamic interrelations between multiple time series included in a vector.

There are several advantages from the VAR model approach. First, the VAR model does not requires introducing restrictions, besides lag-length restrictions, imposed by the theory about the relationships that we are describing, treating all variables as endogenous. For this reason, VAR models are sometimes referred to as atheoretical models. Since there is still no consensus about who bears the burden of the corporate income tax, this offers a significant advantage because this estimation method basically allows the data to "speak freely" (Hoover et al., 2008, p. 254). More importantly, this characteristic does not rules out the possibility that we can formulate and test "hypotheses with economic content" (Sims, 1980, p. 16). Further, the estimation of *impulse-response functions*, an important component of Vector Autoregressions, will allow to assess in a simple graph the short- and long-term effects of corporate tax changes on the variables of interest. Finally, given certain conditions, VAR models can be easily estimated through OLS regressions.

The vector autoregression model to be estimated can be represented as follows:

$$\mathbf{X_t} = A(L)\mathbf{X_{t-1}} + B(L)\mathbf{D_t} + \epsilon_\mathbf{t} \tag{8}$$

where $A(L)$ and $B(L)$ are finite vector ordered polynomials in nonnegative powers of the lag operator, L. $\mathbf{X_t}$ is a vector of endogenous regressors, $\mathbf{D_t}$ is a vector representing the exogenous changes in the corporate income tax, or Romer & Romer shocks, and $\epsilon_\mathbf{t}$ is a vector of error terms, or shocks. Particularly, $\epsilon_\mathbf{t} \sim$ i.i.d. $N(\mathbf{0}, \mathbf{\Omega})$. The vector $\mathbf{X_t}$ includes variables that measure the rate of return on corporate capital RCK_t, the average tax rate ATR_t, wages W_t, and the price of goods and services P_t. Due to the limited sample size (at most 63 observations for each industry), I sometimes substitute ATR_t for other regressors, such as the real gross domestic product $GDPr_t$, or the output gap as it is standard in the literature.[18]

The vector D_t is of particular interest because it contains the exogenous corporate tax

[18]The output gap is calculated as the difference between $GDPr$ and its time trend, with the trend calculated using a Hodrick-Prescott filter.

policy changes. As mentioned in section 2.2, the exogenous policy changes are measured using an indicator variable that identifies the dates in which these shocks occurred. That is, $\mathbf{D_t} = 1$ if an exogenous policy change (tax increase or decrease) in the CIT occurred in year t, and 0 otherwise. Therefore, the response of the endogenous variables in $\mathbf{X}$ to a exogenous change in corporate tax policy will be given by the polynomial expansion of $[\mathbf{I} - \mathbf{A(L)L}]^{-\mathbf{1}}\mathbf{B(L)}$.[19]

Alternatively, for a particular equation in (8), it is possible to obtain the impulse-response function to show the effect of a shock in the jth variable at time t on the value of the ith variable at time $t + s$, once the effects of all other variables in the model are controlled for—e.g., consider the effect of a shock in the average tax rate, ATR_t, on the rate of return to corporate capital, RCK_{t+s}. For this purpose, we write the VAR model in equation (8) as a linear function of past innovations:[20]

$$\mathbf{X_t} = \mu + \epsilon_\mathbf{t} + \mathbf{\Psi_1}\epsilon_\mathbf{t-1} + \mathbf{\Psi_2}\epsilon_\mathbf{t-2} + \dots \tag{9}$$

where each matrix $\mathbf{\Psi_s}$ measures the effect of $\epsilon_\mathbf{t}$ on the future observation $\mathbf{X_{t+s}}$. That is,

$$\frac{\partial \mathbf{X_{t+s}}}{\partial \epsilon_\mathbf{t}'} = \Psi_s; \tag{10}$$

Thus, the (i, j) element of $\mathbf{\Psi_s}$ measures the impact of a one-unit change in the innovation of the j variable at t (ϵ_{jt}) on the ith variable at time $t + s$ ($\mathbf{x_{i,t+s}}$), holding all the other innovations at all dates constant.

4 Estimations and Results

Figures 2 and 3 show the impulse response functions. The columns present the effect of a exogenous increase in the corporate income tax on the rate of return on corporate capital RCK (column 1), the worker's wages (column 2), and the price of goods and

[19] This approach also allows to test for asymmetries in tax policy changes: (i) corporate tax rate increases and (ii) corporate tax rate decreases. Refer to section 2.2 to see the years for which D_t represents exogenous increases or decreases in the CIT.

[20] Equation (9) is known in the literature as the moving average (MA) representation of a VAR model.

services (column 3). Each row or section corresponds to a particular sector, and the scale on the ordinal axis ("x" axis) of each individual chart measures time in years. Following a common practice in this literature (Sims and Zha, 1999; Ramey, 2011), the bootstrap standard error bands shown are 68% bands.

The first row in figure 2 shows the effect of a exogenous increase in the corporate income tax on the return, or cost, of corporate capital, wages, and prices, respectively, for the Mining sector. The cost of corporate capital initially increases about 0.1% (or 10 basis points) with the introduction of the tax. Over time, the RCK reaches slowly its pre-tax level in approximately 17 years. The increase in the corporate cost of capital causes a significant drop of approximately 2% in the wage rate. After two years of the imposition of the tax, worker's wages slowly increases, but never come back to the pre-tax level. Thus, the increase in the cost of corporate capital is more than offset by a decline in the wage rate. In other words, this could be the case in which corporate owners shift (more than fully) the burden of the CIT to workers. Under the assumption that prices for mining products are tradable and homogeneous in international markets, they will not change with the imposition of the tax. However, we observe a permanent drop in the price of mining products, which could be explained by the firm's gains obtained from a permanent decline in labor cost.

The second section in figure 2 illustrates the effect of the CIT on the Manufacturing sector. Similar to Mining, the impulse response functions show that the increase in the CIT raises the cost of corporate capital, returning to its pre-tax level after four years. However, wages in the manufacturing sector significantly increases with the tax. For a tradable sector with imperfect substitute goods such as Manufacturing, the models of Harberger (2008a,b), Gravelle and Smetters (2006), and Randolph (2006) suggest that the respond to prices will depend on the degree of capital (or labor) intensity with respect to the numeraire sector. For Manufacturing, prices increases as a response to the higher cost in both capital and labor.[21]

[21]The capital share in Manufacturing (36%) is significantly lower than Mining (68%), thus the labor

Panels three and four show the impulse response functions for the Agriculture and Services sectors, respectively. In both, the return to capital drops as capital moves from the corporate to the non-corporate sector. However, while we observe a permanent negative effect in the rate of return to capital in Services, the return in Agriculture becomes positive after five years. This positive effect might be explained by the rise in the return to land, which is part of the return to capital and it is not accounted for in the model. In the open economy model of Harberger (1995, 2008a,b), agricultural prices do not change because products are assumed to be tradable and homogeneous. But given that the United States economy is a major world producer for some commodities (e.g., corn, wheat, etc.), thus affecting international markets, it is plausible to expect that agricultural prices will react to the tax. Therefore, the decline in the return of corporate capital causes a reduction in the prices of agricultural products. For Services (non-tradable), prices unambiguosly decline as a result of a lower labor and capital cost, as predicted in Harberger (1995, 2008a,b).

Figure 3 shows the impulse response functions for the Transportation & Utilities, Finance & Insurance, Wholesale & Retail Trade, and Construction sectors. For Transportation & Utilities (corporate, non-tradable), the effect of an increase in the CIT is exactly what the model would predict. The CIT raises the cost of corporate capital, increasing the gross rate of return approximately 0.2%, or 20 basis points. The cost of corporate capital takes about 12 years to pull back to its pre-tax level. The wage rate initially drop by 0.5% to absorb tax tax-wedge, and almost never return to its pre-tax conditions, thus significantly affecting workers in this sector. Prices significantly increase as a result of the large capital intensity of the Transportation & Utilities sector.[22]

For Finance & Insurance (corporate, tradable), panel two in figure 3, the CIT has a significant and negative impact on the return to corporate capital. The rate of return

cost will have a larger weight than the capital cost in determining the evolution of prices for manufacturing products. See table XXX for details.

[22]For Transportation & Utilities, the average value added to capital is approximately 51% for the period from 1947 to 2009.

initially drops by 0.08%, then slowly moves to its pre-tax level in about ten years. Wages and prices both significantly increase with the imposition of the tax. For the Wholesale & Retail Trade and Construction sectors, the response to an exogenous increase in the CIT, panels three and four, respectively, causes an increase in the cost of corporate capital. In both, the wage rate declines to absorb the tax-wedge. Prices in Construction and Trade sectors significantly increase, affecting consumers in both sectors.

The previous results are generally in light of Harberger (1995, 2008a,b) predictions. An exogenous increase in the CIT raises the cost of capital in the corporate sectors of Mining, Manufacturing, Transportation & Utilities, Wholesale & Retail Trade, and Construction due to the imposition of the tax-wedge. For the non-corporate sectors, such as Agriculture and Services, the return to corporate capital declines with the tax. The Finance & Insurance sector, which is corporate and highly capital intensive, is an exception in which the cost of corporate capital declines after the imposition of the CIT. Therefore, this analysis suggests that, in the short-term, capital owners burn the burden of the corporate income tax.

For an open economy with perfectly homogeneous and tradable goods, Harberger (1995, 2008a,b) predicts that wages will decline economy-wide to fully absorb the CIT. In other words, the response of wages will depend on the degree of competition and the availability of product substitutes that producers will face in international markets. The estimations above show that wages significantly declines across all non-tradable sectors, i.e., Services, Transportation & Utilities, Construction, and Wholesale & Retail Trade. For the Mining sector, which could be assume that produces an homogeneous and tradable good (e.g., fuel and nonfuel minerals) wages are also negatively impacted with the tax.[23] However, in Manufacturing and Agriculture, both tradable with imperfect homogeneous goods, wages significantly increase after the imposition of the CIT.

Finally, the effect of the CIT on the price of goods and services will depend on the

[23]In 2010, the U.S. exports of mineral raw materials (e.g., gold, soda ash, zinc, concentrates, etc.) totaled $7.5 billion, while exports of processed minerals (e.g., metals, chemicals, etc.) were $87 billion (Survey, 2011).

capital shares of each industry analyzed. The results show that for highly capital intensive sectors, i.e., Manufacturing, Transportation & Utilities, Finance & Insurance, and Wholesale & Retail Trade, prices increase with the tax. Further, prices decline for sectors with a relative low capital income share: Mining, Agriculture, and Services. Therefore, these results validate the original predictions from Harberger (1995, 2008a,b) on the effect of an exogenous increase of the corporate income tax for a multi-sector open economy.[24]

[24]The estimates of the capital income share in Agriculture and Mining are 74% and 43%, respectively. However, these large estimates, compared to other sectors in the economy, are attributed to the land income share, which is also part of the capital income share, in both Agriculture and Mining. For example, Valentinyi and Herrendorf (2008) find that Agriculture has the largest land share in the economy (18%), which is approximately one-third of Agriculture's total income share to capital.

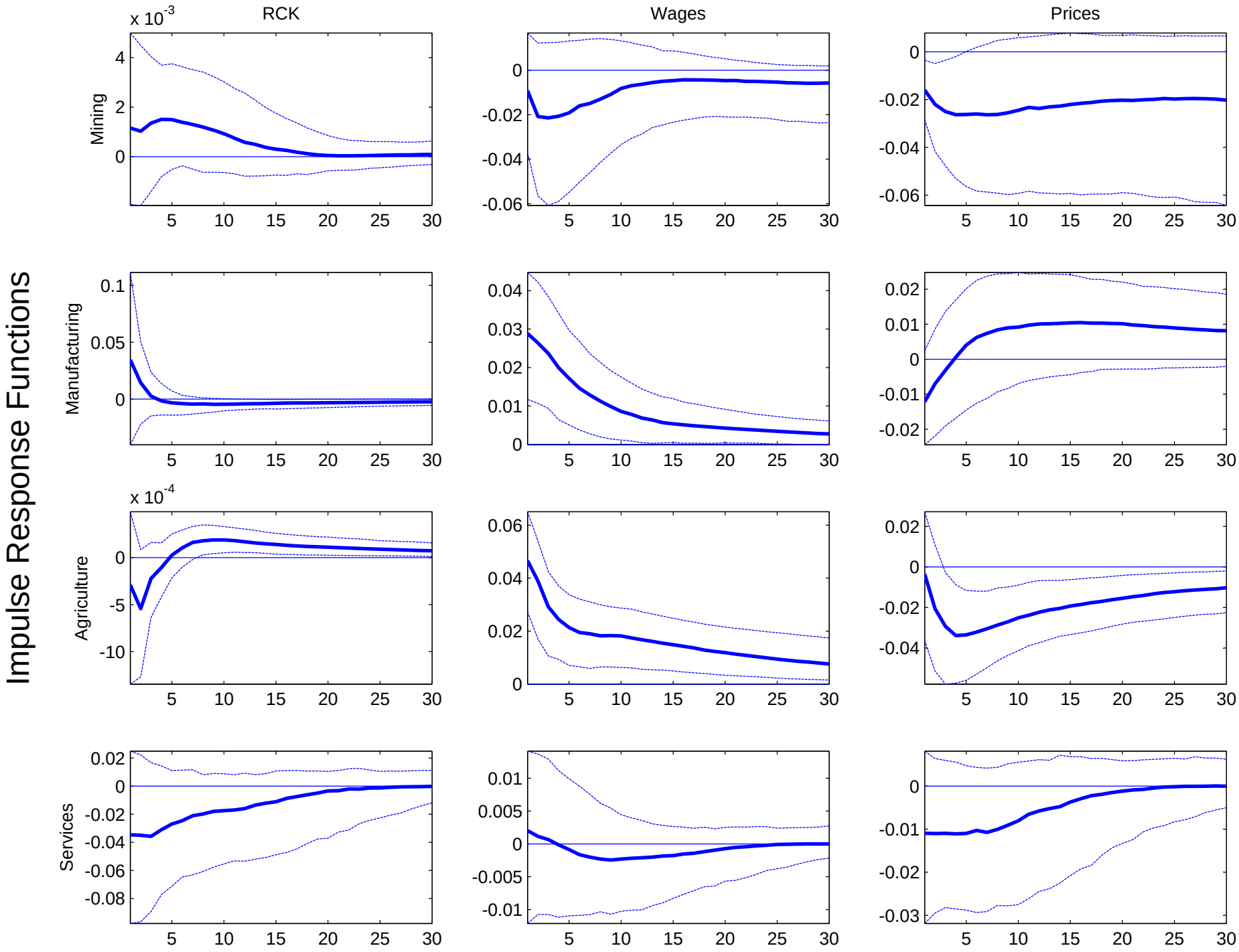

Figure 2: Exogenous increase in the CIT

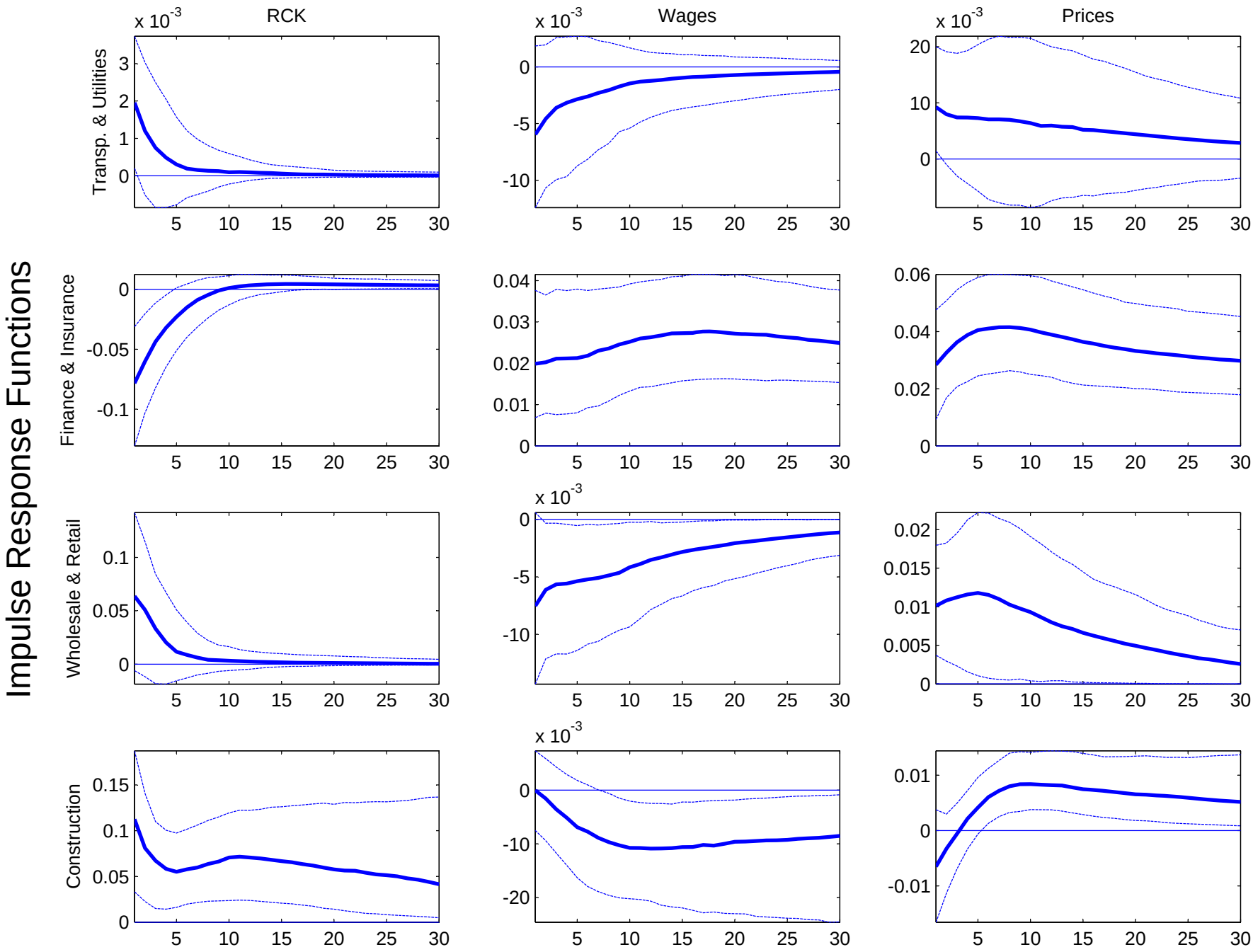

Figure 3: Exogenous increase in the CIT

5 Conclusions

This paper emploies a new and better methodology that allows for improved analysis of how the incidence of the corporate income tax (CIT) is distributed over time among workers, consumers, and capital owners. Using annual information for the period from 1945 to 2007, I analyze the effects of an exogenous changes in corporate tax policy on the rate of return to corporate capital, the wage rate, and the prices of goods and services for eight major U.S. industries: (i) Agriculture, (ii) Mining, (iii) Construction, (iv) Manufacturing, (v) Public Utilities and Transportation, (vi) Wholesale & Retail (Trade), (vii) Finance & Insurance, and (viii) Services. The identification of the exogenous changes on the CIT is based on the work of Romer and Romer (2009, 2010), who provide an extensive analysis of the U.S. federal tax legislation using narrative records from presidential speeches and congressional reports, among other documentations.

The results are generally consistent with the predictions of Harberger (1995, 2008a,b) models. An exogenous increase in the CIT raises the cost of capital in the corporate sectors of Mining, Manufacturing, Transportation & Utilities, Wholesale & Retail Trade, and Construction due to the imposition of the tax-wedge. As capital flows from the corporate to the non-corporate sectors, such as Agriculture and Services, the return to corporate capital declines. Further, the wage rate declines to absorb part of the tax wedge imposed with the CIT. The drop wages is significant across all non-tradable sectors, i.e., Services, Transportation & Utilities, Construction, and Wholesale & Retail Trade, but not economy-wide. For tradable sectors producing an homogeneous good, such as Mining, wages also decline. However, in Manufacturing and Agriculture, both tradable with imperfect homogeneous goods, wages significantly increase with the CIT.

The estimations show that the CIT raises the prices of goods and services for high capital intensive industries (i.e., Manufacturing, Transportation & Utilities, Finance & Insurance, and Wholesale & Retail Trade). For sectors with a relative low capital income share, such as Mining, Agriculture, and Services, prices decline with the tax.

Finally, these results validate the original predictions from Harberger (1995, 2008a,b) on the effect of an exogenous increase of the corporate income tax for a multi-sector open economy. Although, this paper does not calculates numerical burdens of the CIT, Harberger (1995) obtains plausible estimations based on the results discussed above. He concludes that U.S. capital bears a small burden of the CIT (about 25% of total CIT receipts), while labor bears approximately 100% of the burden of the U.S. CIT. Further, both capital owners and workers receive a benefit in their role as consumers, but this gain is offset by the benefits obtained by landowners.

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