National Tax Journal, March 2013, 66 (1), 185–214

CORPORATE TAX INCIDENCE: REVIEW OF GENERAL EQUILIBRIUM ESTIMATES AND ANALYSIS

Jennifer Gravelle

This paper identifies the major drivers of corporate tax incidence in open-economy general equilibrium models and compares estimates from four major studies. These studies vary in their elasticity assumptions, and adjusting the estimates to reflect central empirical estimates of those elasticities suggests capital bears the majority of the corporate income tax burden. This paper further presents an alternative method for determining corporate tax incidence that distinguishes between global effects of corporate taxes and excise effects that vary among nations. Under this approach, even in an open economy, capital could bear virtually the entire tax burden.

Keywords: corporate tax incidence, general equilibrium models, Harberger model

JEL Codes: H22, H25, H73

I. INTRODUCTION

Who bears the burden of the corporate income tax? For years following the publication of Harberger's seminal paper in 1962, his conclusion — that the burden of the corporate tax tends to fall entirely on capital — has largely withstood modifications to his model's underlying assumptions. Those adjustments, however, were generally made within the context of a closed economy, in which there was no trade and no capital flows between countries. Introducing an open economy into the model would appear to shift the burden from capital toward labor, because labor is generally less mobile than capital and because capital owners could avoid domestic tax by shifting investment overseas. However, the few studies that have modeled corporate tax incidence within an open economy do not reach a consensus on the degree to which the tax burden is shifted to labor. Moreover, even with well-developed, open-economy models there are several issues in relying on this type of analysis to allocate existing corporate taxes, including the assumption that corporate taxes in other countries either do not exist or do not respond to changes in the U.S. tax.

Jennifer Gravelle: Congressional Budget Office, Washington, DC, USA (jennifer.gravelle@cbo.gov)

This review presents a detailed analysis of the assumptions in the open-economy models of the corporate income tax that account for differences in their findings, and it provides a central estimate of corporate tax incidence based on those studies. The paper also considers an alternative approach that draws on the new view of property tax incidence, which distinguishes between national effects attributable to imposition of property taxes in numerous localities and excise effects that vary among states due to deviations from the implicit national tax rate.[1] Under that approach, corporate tax incidence can be viewed from a global perspective, taking into account the excise effects that result from differences across countries in their corporate tax rates.

II. EARLY ANALYSIS OF CORPORATE INCIDENCE: CLOSED ECONOMY MODELS

Following the introduction of the corporate tax in 1909, economists struggled to analyze a new tax that was quite different from the more familiar excise or property taxes. Although they disagreed on exactly where the burden of the corporate tax would fall, there was general agreement that the tax could not be shifted forward to consumers in the short run. Prior to 1962, economists relied on partial equilibrium analysis, but attempted to examine the corporate tax within a general equilibrium context by looking at its effect on factor taxes, factor returns, and product prices. The analysis, however, was generally piecemeal, qualitatively based, and lacked a comprehensive theoretical framework.[2]

Perhaps because of the early uncertainty about how to analyze corporate tax incidence, research initially turned to new methods of empirical analysis. Krzyzaniak and Musgrave (1963) used emerging regression techniques to explain rates of return on capital as a function of tax rates. They found that more than 100 percent of the tax was shifted to consumers in the short run. This result was inconsistent with theoretical models of profit maximization in competitive markets. In several studies, economists tested Krzyzaniak and Musgrave's results, some finding contradictory results and some confirming the analysis. Cragg, Harberger, and Mieszkowski (1967) cautioned that one should be skeptical of a framework generating fragile and volatile outcomes. Around the same time that Krzyzaniak and Musgrave were conducting their empirical analysis, Harberger (1962) was developing his general equilibrium model of corporate tax incidence. At that time, the uncertainty surrounding empirical results appeared to have led the research community to abandon empirical analyses in favor of Harberger's new theoretical model. Recently, however, there has been a resurgence of the empirical approach to determining the incidence of corporate taxes.

Harberger employed an approach drastically different from direct empirical analysis by constructing a theoretical two-sector closed economy general equilibrium model to

[1] Although widely known as the "new" view of property tax incidence, this view was first developed by Mieszkowski (1972) and extended in Zodrow and Mieszkowski (1986).

[2] Auerbach (2005), Gravelle (2009), and McLure (1975) provide more details on the early developments of the theory of corporate tax incidence.

trace the effects of a tax on capital income in one sector. A primary contribution of his model to the early analysis of corporate tax incidence was that the burden of the tax is borne by factor income — capital and labor — and is not shifted forward to consumers. Harberger (1962) identified some general conclusions about the relative burdens of the two factors. First, labor can bear a higher proportion of the tax than its initial share of income only if the taxed industry is labor-intensive. Second, capital will bear more of the tax burden than labor (relative to initial income shares) only if the factor substitution elasticity within the taxed sector is greater than the product substitution elasticity between sectors. Third, the higher the elasticity of factor substitution in the untaxed sector, the more likely it is that labor and capital will bear the tax in proportion to initial income shares. Based on his model specification and his views regarding plausible estimates for the values of the relevant elasticities, Harberger concluded that the majority of the tax burden fell on capital.

Following Harberger's work, numerous studies made further refinements and adjustments to the original model.[3] Although those studies sometimes yielded different results, none of them ruled out the possibility that, under largely reasonable assumptions, capital would bear a large share of the corporate tax burden under a closed economy assumption.

III. OPEN-ECONOMY MODELS OF CORPORATE TAX INCIDENCE

Although these variations of the basic Harberger model still suggested that capital largely bore the burden of the corporate tax, they all assumed a closed economy. Introducing an open economy into the Harberger model allows for the possibility that capital will flow abroad, which could shift some of the burden from capital, the now more mobile factor, to immobile labor. At the extreme, for example, if a country is small and capital is perfectly mobile in a one-good economy, domestic labor bears 100 percent of the burden. As global interactions and the importance of large multinational corporations increased, it became clear that a comprehensive analysis should assume an open-economy framework to determine how much of the burden of the corporate tax is shifted from capital to labor.

This analysis considers four major studies that use a general equilibrium model similar to Harberger's original approach but extended to an open-economy framework. The results from these studies vary and have led to uncertainty about the burden of the corporate income tax in the long run.

---

[3] Shoven (1976) incorporated more subsectors within the corporate and noncorporate sectors. Batra (1975), Ratti and Shome (1977a, 1977c), and Baron and Forsythe (1981) all make adjustments to the Harberger model to allow for uncertainty. Ratti and Shome (1977b) add land as a third factor and test to see what elasticity assumptions are needed to ensure that capital bears 100 percent of the corporate tax burden. Atkinson and Stiglitz (1980) show that, with a variety of imperfections in the factor and/or product markets, Harberger's results do not generally hold. Bhatia (1981) introduces intermediate goods to the analysis. Parai (1988) uses Harberger's model and incorporates variable returns to scale. Gravelle and Kotlikoff (1989) investigate the effects of corporate and noncorporate production in both sectors in the model. Parai and Choudhary (1992) allow for imperfect labor mobility.

A. Key Assumptions Determining Results

The results of the general equilibrium models are driven by certain key assumptions. In the closed-economy model, the three most important drivers were the extent of product substitution between the taxed and untaxed sector, the extent of factor substitution within sectors, and the relative factor intensities of the untaxed and taxed sectors. When a traded sector is added to the basic Harberger model, five assumptions emerge as the key drivers of the results. Three assumptions result from the open-economy model: the mobility of capital across nations, the mobility (or substitutability) of products across countries, and the size of countries. Two assumptions are the same as in the closed-economy model: the potential for factor substitution within sectors and relative factor intensities in different sectors of the economy.[4] Table 1 summarizes the effects of these open-economy assumptions, and the following discussion describes the underlying economic forces. Unlike closed economy models, open economy models differentiate between domestic factors and foreign factors. The discussion of drivers applies to domestic factors.

1. International Mobility of Capital

If capital is perfectly mobile (there is perfect portfolio substitution where shareholders view their holdings of foreign and domestic stock as equivalent) across borders, the corporate tax reduces the return to capital in the domestic corporate sector, and drives capital abroad. As the capital stock in the domestic country falls, the marginal product of the remaining capital rises until the after-tax return equals the return prior

Table 1

Major Corporate Tax Incidence Drivers and Their Effects on the Tax Burdens Falling on Capital and Labor

Major Open Economy Driver	Share Falling on Capital	Share Falling on Labor
High international capital mobility	↓	↑
High international product substitution	↓	↑
Large country	↑	↓
Higher factor substitution	↑	↓
Taxed sector more capital-intensive	↓	↑

[4] The substitutability of demand for products within the country will have effects that interact with factor intensity as in the closed-economy model; if the taxed sectors are more labor-intensive, a lower substitution elasticity reduces the demand for labor less and causes less of the burden to fall on labor.

to the tax. Immobile labor bears a larger portion of the tax as the smaller remaining capital stock reduces the marginal productivity and thus the demand for labor relative to capital, driving down wages. The less internationally mobile capital is, the less the burden can be shifted to labor.

2. International Product Substitution

If domestic and foreign products are not perfect substitutes, the demand for domestic goods is less elastic. If a tax is then imposed in the domestic corporate sector, the demand for domestic goods will not fall as much as in the case of perfect substitutes, as domestic buyers are less willing to substitute the imported foreign product for the domestically-produced version. Imperfect product substitution reduces the ability of the taxed sector to shift capital abroad, and foreign markets are less willing to absorb the excess capital because they do not face as much increased demand for their version of the products. This product rigidity effectively makes the taxing country more like a closed economy.

3. Size of Country

The size of the country determines its ability to influence worldwide factor prices. Consider a one-good model with perfect international capital mobility and perfect international product substitution under different assumptions about the sizes of the countries. If the country is small, the worldwide return to capital and the prices of traded goods are fixed and, because factor payments must be exhausted, labor income will fall by the total amount of the tax imposed on capital income — that is, labor will bear 100 percent of the burden. However, if the country is large enough to affect worldwide prices, then, as capital flows abroad after the imposition of the tax, the increased capital in the world market will reduce the world return to capital. Even though the reduced domestic capital stock in the taxed country causes that country's marginal product of capital to increase until it equals the worldwide return, that worldwide return is lower. The share of the tax that capital will bear, under perfect international capital and product mobility, is equal to the taxing country's share of world output.

4. Factor Substitution

The less firms can substitute labor for capital, the larger the burden that labor will bear. As the demand for capital is reduced, if labor is closely tied to capital (that is, if the two are not easily substitutable), the demand for labor will also fall, driving down wages. For example, in the closed economy, as the demand for capital falls and firms in the taxed sector wish to reduce their excess capital, if it is difficult in the taxed and other sectors to substitute labor for capital, then the demand for labor falls relative to capital and depresses wages. In the open economy, as capital flows abroad because of the tax, if labor is not substitutable for capital, the value of the lost capital rises and the

demand for the now excess labor falls, driving down wages and increasing the return to capital. As a result, because it is the immobile and nonsubstitutable factor, labor will bear a larger burden.

5. Factor Intensities

Factor intensities affect corporate tax incidence by determining the relative size of the tax and the base that absorbs the tax. Regardless of the size of the corporate sector, if the taxed sector is capital-intensive then the share of tax to be absorbed by labor in that sector will be larger than the share of the tax absorbed by labor in a labor-intensive taxed sector. That is, in order to keep prices from rising, the corporate sector must first absorb the tax through reductions in wages. If that sector is capital-intensive, then it has a smaller labor-income base to absorb that cost through decreased wages, relative to the size of the tax, and thus the reduction in wages will be relatively larger. With competitive labor markets, that large reduction in wages will spread to labor in all other sectors; thus, the more capital-intensive the taxed sector, the more that labor will bear the burden.

B. Summary of Major Open-Economy Studies

Four major studies have used variants of Harberger's model in an open-economy setting to examine the sensitivity of the effect of international capital flows on the shifting of the corporate tax burden from capital toward labor: Grubert and Mutti (1985), Gravelle and Smetters (2006), Randolph (2006), and Harberger (2008). The following discussion reviews the assumptions made in these studies regarding the five major factors discussed above and their main results. Tax burdens can also be exported and some of the implications of exporting corporate tax burden are discussed in section five. The remaining analysis generally focuses on the four models' results for the share of tax burden falling on domestic capital and labor and provides explanations for the sources of the differences.

1. Grubert and Mutti (1985)

Grubert and Mutti (hereafter GM) model an open economy with two trading partners: the United States and a foreign partner representing the rest of the world. GM have three sectors: an exporting sector, an importing sector, and a sector that is not involved in trade. Firms use three factors: capital, skilled labor, and unskilled labor. For the key drivers, GM assume the following: (1) international capital mobility (portfolio substitution) ranges from imperfect to perfect with elasticities of 0.4, 1, 3, and 300 (300 is effectively the same as perfect mobility); (2) international product substitution is imperfect with an elasticity of three; (3) the country is large and affects factor prices in the world market; (4) the nontraded (noncorporate) sector is more capital-intensive than the export sector; and (5) the factor substitution elasticities between capital and

unskilled labor and between skilled labor and unskilled labor are both 0.6. The factor substitution elasticity between capital and skilled labor is 0.05.

Table 2 provides selected results from GM's study. Their main findings show that with perfect capital mobility (the capital mobility elasticity equals 300), 14 percent of the corporate tax burden falls on domestic capital. Reducing capital mobility increases the amount of the tax that domestic capital bears. GM measure corporate tax incidence on capital owned by U.S. residents as well as on domestic capital. As can be seen, when capital is not perfectly mobile, the burden will be smaller on all capital owned by U.S. residents than on domestic capital, because the after-tax return in the United States will fall more than the after-tax return abroad.

2. Gravelle and Smetters (2006)

Gravelle and Smetters (hereafter GS) also model two trading partners: the United States and another country representing the rest of the world. GS assume corporate and noncorporate sectors, and divide each of those two sectors into traded and nontraded sectors, for a total of four sectors. Firms in three sectors rely on capital and labor. The traded noncorporate sector —agriculture — includes land along with capital and labor. The key model assumptions are: (1) international capital mobility (portfolio substitution) is either imperfect or perfect, with elasticities of 0.1, three, and 100 (100 is effectively equivalent to perfect substitution[5]); (2) international product substitution is either imperfect or perfect, with elasticities of one, three, and 100 (100 is effectively equivalent to perfect substitution); (3) the country is large and affects factor prices in the world market; (4) the nontraded noncorporate sector is more capital intensive than the corporate sectors (as assumed in GM); and (5) the traded corporate sector and nontraded corporate sector are both labor-intensive (similar to GM), although GS

Table 2

Corporate Income Tax Burden
(Percent falling on capital)

	Capital Mobility Elasticity				
Type of Capital	0	0.4	1.0	3.0	300
Domestic capital	100.3	65	43.5	26.1	13.9
Domestically owned capital	n/a	52	35.9	22.3	13.9

Source: Grubert and Mutti (1985)

[5] Although GM use a much higher elasticity of 300 to approximate perfect substitution, elasticities converge quickly to perfect response, so an estimate of 100 still effectively simulates perfect substitution.

consider variations in capital intensity. The factor substitution elasticities assumed are 0.8, one, and 1.2.

Table 3 shows GS's initial results for the domestic and foreign shares of the burden of the tax, assuming, as do GM, that capital goods are produced domestically. In this table, factor substitution elasticities are unitary, and the United States accounts for about 30 percent of the world market. As can be seen, if both capital and products are highly substitutable internationally, GS find domestic capital's share of the tax burden is 35 percent. As noted earlier, with perfect international mobility, domestic capital's share of the tax burden will equal the country's share of world output. Note also that the burden shares do not total to one, as the foreign economy benefits and the domestic economy bears more than 100 percent of the burden of the tax. Much of the capital burden is borne by foreign capital and, generally, foreign labor benefits from the increased capital flowing abroad.

Reducing the mobility of capital greatly changes the domestic allocation of the incidence of the corporate tax between capital and labor. If capital mobility is assumed to be perfect (100), 73 percent of the burden is borne by domestic labor and 35 percent by domestic capital. Reducing the capital mobility elasticity to three changes the allocation of the burden to 28 percent on domestic labor and 73 percent on domestic capital. Reducing the elasticity further to 0.1 causes virtually the entire corporate tax burden to fall on domestic capital.

Changing the product substitution elasticity does not substantially affect the share of the burden borne by domestic capital but has large impacts on the share borne by domestic labor. Reducing the product substitution elasticity to three changes the burden allocation to 55 percent on domestic labor and 36 percent on domestic capital. At a product substitution elasticity of one, 21 percent of the burden falls on domestic labor

Table 3

Corporate Tax Burden with Unitary Factor Substitution

	Burden that Falls on Domestic Labor (%)			Burden that Falls on Domestic Capital (%)		
Product Substitution Elasticity	CME 0.1	CME 3	CME 100	CME 0.1	CME 3	CME 100
1	–3	5	21	90	70	38
3	3	21	55	92	72	36
100	6	28	73	93	73	35

Note: CME denotes capital mobility elasticity.
Source: Gravelle and Smetters (2006)

and 38 percent on domestic capital. Imperfect product substitution reduces the benefits gained by foreign labor and increases the burden on foreign capital.

GS also provide a series of sensitivity results for factor substitution elasticities and capital intensities. These results are shown in Table 4. With perfect international product substitution and perfect international capital mobility, changes in the factor substitution elasticity do not have nearly as much of an effect as when product substitution and capital mobility are more restricted, at less extreme values of three. When both the product substitution elasticity and the capital mobility elasticity equal 100 (perfect substitution), an increase in the factor substitution elasticity from 0.8 to 1.2 increases the percent of the tax burden that falls on domestic capital from 33 percent to 37 percent. But when both the product substitution elasticity and the capital mobility elasticity are equal to three, an increase in the factor substitution elasticity from 0.8 to 1.2 increases the burden on domestic capital from 67 percent to 78 percent.

3. Randolph (2006)

Randolph formalizes Harberger's 1995 open-economy model, allowing for changes in product prices and different assumptions on capital intensities and output shares. As with the previous studies, Randolph models two trading partners: the United States and

Table 4

Effect of Factor Substitution Sensitivity on Corporate Tax Burden

	Factor Substitution Elasticity of 0.8						Factor Substitution Elasticity of 1.2					
	Burden that Falls on Domestic Labor (%)			Burden that Falls on Domestic Capital (%)			Burden that Falls on Domestic Labor (%)			Burden that Falls on Domestic Capital (%)		
	CME			CME			CME			CME		
Product Substitution Elasticity	0.1	3	100	0.1	3	100	0.1	3	100	0.1	3	100
1	1	13	30	86	64	34	–7	0	12	93	75	42
3	7	27	60	88	67	33	0	16	51	95	78	38
100	10	33	74	89	68	33	3	23	72	95	78	37

Note: CME denotes Capital Mobility Elasticity.
Source: Gravelle and Smetters (2006)

another country representing the rest of the world. Following Harberger's open-economy model, he includes five sectors. The first three are all part of the corporate sector: a traded sector whose products are perfect international substitutes, a traded sector whose products are imperfect international substitutes, and a nontraded sector. The last two sectors are noncorporate: a traded sector for agricultural products and a nontraded sector. Each sector relies on two factors — capital and labor — and the agricultural sector includes land as well. Randolph's key model assumptions are as follows: international capital mobility (portfolio substitution) is perfect; (2) international product substitution is perfect;[6] (3) the size of the country varies under different scenarios, but world factor prices are not assumed to be fixed; (4) the corporate sector is more labor-intensive than noncorporate sectors are (as in GS); and (5) the factor substitution elasticity is 0.6, although Randolph notes that changing that value to one does not change the results significantly.

Table 5 summarizes some of the major results from Randolph's analysis. His simulations with perfect international mobility of capital and products confirm the standard effect of country size (see the first and last rows of the table). As can be seen by comparing row 1 and row 4, with perfect international mobility and a given capital intensity, country size largely determines the allocation of the tax burden. Randolph's second set of results (in row 2 and row 3) illustrates the sensitivity of the results to assumptions about capital intensity.

Recall that Randolph's first two sectors were traded corporate sectors that varied in the substitutability of their products, with the second sector having domestic and imported products that were not perfect substitutes. Initially, he assumes that each traded corporate sector is equally capital-intensive. Increasing capital intensity in the less-substitutable sector allows the bulk of the tax to be imposed in a sector with less capital mobility, reducing the ability to shift the tax to labor. If, instead, capital intensity is increased in the more-substitutable sector, then most of the tax would be imposed in a sector with great capital mobility, allowing domestic capital to escape the tax by flowing abroad, causing domestic labor to bear the large tax.

Randolph assumes a range of country sizes as a proxy for modeling capital immobility, which avoids some of the complexity of earlier studies. Randolph (2006, p. 32) states that a "simpler approach to changing the degree of capital mobility is to imagine that the rest of the world is smaller, in which case there would be fewer opportunities for capital to be reallocated abroad." Although these adjustments do make the economy less open by restricting the opportunity to move capital abroad and thus exhibit similar

[6] Although Randolph (2006) technically assumes a second traded corporate sector that has imperfect international product substitution, it is the traded corporate sector with perfect international product substitution that drives the results. The nominal wage changes are determined first by the price-taking traded corporate sector with perfect international product substitution. Those effects are then traced through to the second corporate sector, where the incidence results are determined by the relative capital intensities of the two corporate sectors. The imperfect product substitution of the second corporate sector does not affect the incidence results; rather, it ensures that there is no corner solution to the model.

Table 5

Effect of Country Size and Capital Intensity on Corporate Income Tax Burden

Assumptions	Share of Burden on Domestic Labor (%)	Share of Burden on Domestic Capital (%)
Perfect product substitution (corporate taxable sectors 1 and 2 have equal capital intensity), and domestic country share of output is 30 percent	73.7	32.5
Corporate taxable sector 2 is more capital-intensive than corporate taxable sector 1	59.0	37.5
Corporate taxable sector 2 is less capital-intensive than corporate taxable sector 1	90.6	26.7
Perfect product substitution, and domestic country share of output is 70 percent	32.5	72.7

Source: Randolph (2006)

results (the less open the economy, the more the burden falls on capital), they should not be interpreted as allowing for differences in the capital-mobility elasticity, which work differently within the model than do variations in country size. Specifically, with perfect capital mobility and perfect product substitution, country size has predictable effects, as the share of the burden falling on domestic capital will approximate the share of the country's worldwide output. Imperfect capital substitution will not have the same expected effects on the share of burden borne by capital and labor.

4. Harberger (2008)

Harberger does not explicitly provide a detailed two-country model.[7] Instead, he derives incidence results for a perfect capital mobility scenario by making initial assumptions about the international allocation of the corporate tax burden and changes in the worldwide return to capital. He includes four sectors: a traded corporate sector (manufacturing), a traded noncorporate sector (agriculture), a nontraded corporate sector (public utilities), and a nontraded noncorporate sector (services). Each sector relies

[7] Harberger (2008) uses his 1995 open-economy model but takes into account the changes in the prices of products in other sectors. Randolph (2006) provides a detailed discussion of the effect of this adjustment.

on two factors — capital and labor — and the agricultural sector also includes land. Harberger's key model assumptions are: (1) international capital mobility (portfolio substitution) is perfect; (2) international product substitution is perfect; (3) the country is large and affects factor prices in the world market; (4) in a departure from previous studies, the nontraded noncorporate sector is less capital-intensive than the corporate sectors, with one-quarter of total capital allocated to the corporate traded sector; and (5) Cobb-Douglas production functions with unitary factor substitution elasticities.

Harberger's "illustrative incidence exercise" results in 130 percent of the corporate tax burden falling on domestic labor (Table 6). His exercise assumes that the worldwide burden of the corporate tax falls on all capital, and that one-quarter of the worldwide burden on capital is initially borne domestically (that is, the U.S. economy is assumed to be about one-quarter of the worldwide economy). Assuming a 1 percentage point reduction in the worldwide return to capital, the relative capital intensities in the taxed and untaxed sectors alter the domestic corporate tax burden on labor significantly. He then modifies the assumption that domestic and foreign manufactured goods are homogenous products. When he allows for differences in domestic and foreign products, he reduces the amount of the tax wedge that falls on labor — providing a scenario in which a specified portion of the original burden on wages is instead shifted to consumers through differentially increased product prices. This burden on consumers is allocated to domestic capital and labor in proportion to income shares. With these adjustments, the share of the tax on domestic capital and labor both fall, though more dramatically for domestic labor.

C. Comparisons of Studies: Explanation of Differences

The studies summarized above present different estimates that can be difficult to reconcile at first glance. This section compares the studies and identifies the assumptions that account for differences in the estimates of corporate tax burden. Table 7 provides a summary of the assumptions made by each study.

Table 6

Results of Harberger's Illustrative Incidence Analysis

Assumptions	Share Burden on Domestic Labor (%)	Share Burden on Domestic Capital (%)
Perfect product substitution	130	14
Some separability in world and domestic product prices	96	12

Source: Harberger (2008)

Table 7

Summary of Assumptions of Various Studies

Assumption	Grubert and Mutti	Gravelle and Smetters	Randolph	Harberger
Imperfect capital mobility	Yes	Yes	No	No
Sensitivity analysis	Yes	Yes	No	No
Imperfect product substitution	Yes	Yes	No[1]	Limited[2]
Sensitivity analysis	No	Yes	No	No
Large country	Yes	Yes	Yes	Yes
Sensitivity analysis	No	No	Yes	No
Taxed corporate sector more labor-intensive	Yes	Yes	Yes	No
Sensitivity analysis	No	Yes	Yes	No
Factor substitution Between 0.6 and 1	No	Yes	Yes	Yes
Sensitivity analysis	No	Yes	Limited[3]	No

Notes:

[1] Although there is a sector with imperfect product substitution, the results in Randolph's model are not affected by this sector's international substitution.

[2] Although Harberger did not make an explicit assumption about elasticity values, an adjustment was made for manufacturing factor rigidity.

[3] Randolph tested another factor substitution value but did not provide results.

1. Factor, Product, and Capital Substitution Elasticities

Assumptions regarding factor substitution matter under certain circumstances. Consider the GM and GS studies, which provide scenarios where all the underlying assumptions are similar except for the factor substitution elasticity. Both studies assume a large country and similar relative capital intensities. Both studies also include a scenario in which product and portfolio substitution elasticities are assumed to be the same. We can therefore compare the estimates from each study for the scenarios in which product and capital portfolio substitution elasticities are each equal to three and thus reflect imperfect. Under these assumptions, GM estimate 26.1 percent of the tax burden falls on domestic capital while, in marked contrast, GS find 67 percent falling on domestic capital. The two estimates reflect similar assumptions for four of the major drivers of incidence, and differ only in their assumptions about the factor substitution elasticity. The GS estimate is based on a lower factor substitution elasticity value of 0.8. In contrast, although GM assumes a moderate factor substitution elasticity of 0.6 between unskilled labor and capital, they also assume an extremely low factor substitution elasticity of 0.05 between skilled labor and capital. GS do not show results for factor substitution elasticities less

than 0.8. However, as can be seen from GS's sensitivity results in Tables 3 and 4, with imperfect product and portfolio substitution, reducing the factor substitution elasticity shifts the tax burden from domestic capital to domestic labor, and can do so significantly for small changes. GM's assumption of a factor substitution elasticity of 0.05 between skilled labor and capital 0.05 closely approximates fixed proportions for these two factors. In this case, as capital flows abroad, the taxed sector needs to reduce the quantity of skilled labor by virtually the same amount — greatly driving down the demand for skilled labor relative to capital, which depresses wages and shifts a significant share of the tax burden to domestic labor.

A comparison of GS and Randolph, however, reveals that small differences in factor substitution elasticities may be of little consequence, especially if other parameters are assumed to take on extreme values. Many of the key assumptions in GS and Randolph are the same or quite similar. Both studies make the same assumptions about country size and relative factor intensities (Randolph uses GS's factor-intensity assumptions). In contrast to the scenarios described above, in which product and portfolio substitution was limited, Randolph assumes perfect product and portfolio substitution. Randolph's estimates can thus be compared to GS's estimate under perfect product and portfolio substitution. Even with different factor substitution elasticities — Randolph assumes 0.6 and GS's low assumption is 0.8 — their estimates are roughly the same: Both find about 33 percent of the corporate tax burden falling on domestic capital and about 74 percent falling on domestic labor.

Note that, compared to GM, where a very low factor substitution elasticity between capital and skilled labor had a drastic effect on the estimate of the share of the burden falling on domestic capital, the lower capital-labor substitution elasticity in the Randolph model does not affect the results. When there is perfect international mobility of products and capital, small differences in factor substitution elasticities (Randolph's assumes a value of 0.6 compared to GS's value of 0.8) are dominated by the assumptions of high international capital and product substitution elasticities. In contrast, the large difference between the moderate factor substitution assumed by GS (0.6) and the extremely low value GM assume for skilled labor and capital (0.05) drives the results when the other international substitution elasticities are moderate. Essentially, extreme elasticity assumptions —whether in factor, product, or portfolio substitution — have large effects on the allocation of the burden of the corporate income tax.

2. Factor Intensities

Although GS and Randolph obtain the same tax burden estimates under the assumptions of perfect product and portfolio substitution, there are some sensitivity results in each study that may appear at odds. Both studies allow for variation in factor intensities. GS's equalization of factor intensities makes almost no difference in the allocation of the burden — changing it very slightly, from 73 percent on domestic labor and 35 percent on domestic capital to 74 percent on domestic labor and 34 percent on domestic capital.

By comparison, Randolph's adjustments result in large tax burden changes. Randolph splits the corporate-traded sector into a "more-traded" sector in which domestically produced and imported goods are perfect substitutes, and a "less-traded" sector in which they are imperfect substitutes. When the less traded sector is more capital-intensive, his estimate of the burden on domestic labor falls from 74 percent to 59 percent; conversely the estimate of the burden borne by domestic capital rises from 33 percent to 38 percent. When the more traded sector is more capital-intensive, the share of the tax falling on domestic labor rises from 74 percent to 91 percent; conversely, the burden on domestic capital falls from 33 percent to 27 percent.

The difference between these estimates can be explained as follows. Randolph modifies the assumptions about capital intensities solely within the two traded corporate sectors. As noted earlier, increasing capital intensity in the less traded sector implies the bulk of the tax is imposed in a sector with less product substitution and capital mobility, reducing the shifting of the tax to domestic labor. Increasing capital intensity in the more traded sector causes the bulk of the tax to be imposed in a sector with greater capital mobility, allowing domestic capital to escape the tax and causing domestic labor to bear a large share of the tax. In general, increasing the capital intensity in the traded corporate sector increases the relative amount of a given tax that labor in that sector will have to absorb — and, with perfect capital mobility, domestic labor bears more of a burden.

In contrast, GS change the relative capital intensities between the traded corporate sector and the nontraded noncorporate sector, which produce offsetting effects and little net change in the distribution of the tax burden. GS change relative capital intensities by equalizing capital intensities across all four sectors. In doing so, the increase in capital intensity in the traded corporate sector increases the burden on labor (under the assumption of perfect capital and product substitution). The accompanying decrease in capital intensity in the nontraded noncorporate sector, however, decreases the burden on labor. These opposing forces roughly cancel, resulting in little change in the overall allocation of the tax burden. This can be seen more clearly in the case of imperfect international mobility of capital and products (see Table 3, where GS assume that both the capital substitution elasticity and the international product substitution elasticity are equal to three). In this case, GS find that equalizing capital intensities changes the share of the corporate tax burdens falling on domestic labor and capital from 21 percent and 72 percent to 17 percent and 85 percent, respectively (not shown in Table 3). With imperfect international capital mobility and product substitution, the increase in capital intensity in the traded corporate sector cannot be shifted as easily to labor, thus reducing the impact of the traded corporate sector's higher capital intensity on the tax burden to labor. This relatively small increase in the tax burden on labor, coupled with the relatively large reduction in the tax burden on labor in the nontraded noncorporate sectors, results in a net reduction in the tax burden borne by labor.

Different assumptions about capital intensity in various sectors also account for differences between the results in GS's study and Harberger's findings. In those cases,

perfect portfolio substitution and product substitution are assumed, along with a factor substitution of one.[8] With perfect product and portfolio substitutions, a large economy, and unitary factor substitution elasticities, GS estimate 73 percent of the tax burden will fall on domestic labor and 35 percent on domestic capital. Under these same assumptions, Harberger (2008) finds that 130 percent of the tax burden falls on domestic labor and only 14 percent of the tax burden on domestic capital.

These results obtain because Harberger assumes much greater capital intensity in the traded corporate sector than do GS and Randolph.[9] Furthermore, he assumes the traded corporate sector is more capital-intensive than the nontraded noncorporate sector. As noted earlier when comparing GS and Randolph, if the corporate traded sector is more capital-intensive than the nontraded noncorporate sector, a large amount of tax (due to the large amount of capital in the taxed sector) must be absorbed. With perfect international mobility, the only way for the firm to continue producing is to let wages fall. If there is little labor to absorb a large capital tax and that sector's labor income has to fall by the amount of the tax, then domestic labor at large will bear more than the full burden of the tax, because much of the adjustment occurs through a decline in wages.

In summary, the four studies analyzed find common ground when they make similar assumptions about the key drivers in their models, but deviations in one or more of those assumptions can yield large differences. GS and Randolph have very similar findings, despite small differences in assumptions about factor substitution, when they both assume extreme values for other parameters. GM's results differ from those of GS and Randolph because of significant differences in factor substitution elasticities. The findings in Harberger's study also differ from those in the GS and Randolph studies because of differences in relative capital intensities in the various sectors.

D. Evidence on the Various Elasticities

The analysis thus far has shown the sensitivity of estimates of the corporate tax burden in open economy general equilibrium models to the underlying assumptions made in the models. Although all four studies assume the corporate tax is imposed by a large country, the other major drivers of tax incidence in these models — factor substitution elasticities, the capital mobility elasticity, substitution elasticities between domestically

---

[8] Recall that Randolph assumes a factor substitution elasticity of 0.6, but because of perfect international mobility this assumption does not affect the results significantly.

[9] Harberger (2008) allocates 25 percent of the capital in the economy to the corporate traded sector, 25 percent to the nontraded corporate sector and 50 percent to the nontraded noncorporate sector. He also allocates 20 percent of the labor in the economy to the traded corporate sector, 10 percent to the nontraded corporate sector and 64 percent to the noncorporate nontraded sector. These values do not represent relative capital intensities; assuming capital is about 25 percent of output, capital intensities can be estimated from Harberger's stock allocations: 0.29 for the corporate traded sector (for example, (0.25*0.25)/(0.2*0.75+0.25*0.25)); 0.45 for the nontraded corporate sector; and 0.21 for the noncorporate nontraded sector. The GS assumptions for relative capital intensities are 0.18 for the traded corporate sector, 0.24 for the nontraded corporate sector, and 0.53 for the noncorporate nontraded sector.

produced and imported products, and relative factor intensities — vary greatly across some of the studies.

Harberger's study is the only one that assumed the traded corporate sector was more capital-intensive then the nontraded noncorporate sector. He does not provide information supporting this assumption, except to note that the nontraded noncorporate sector is the services sector. Ultimately, capital intensities in the sectors, albeit difficult to calculate, are observable quantities (GS estimate them) and should not be as uncertain as the relevant elasticities, which measure behavioral responses to specific changes in prices while attempting to hold all other factors constant. Even if establishing exact measures of relative capital intensities is not simple, the large stock of noncorporate owner-occupied housing in the United States suggests that the traded corporate sector is less capital-intensive than the nontraded noncorporate sector.

Determining the correct values of the various elasticities is clearly the primary empirical issue in open-economy models of corporate tax incidence. An extensive review of the empirical studies that have estimated factor, product, and portfolio substitution elasticities is beyond the scope of this paper. However, several recent reviews of the literature provide some insight on likely values for these parameters. Table 8 contains a summary of the major findings from those reviews.

McDaniel and Balistreri (2002) review econometric studies estimating Armington (1969) elasticities, which reflect a constant elasticity of substitution specification for substitution between domestically traded goods and imports. They first note that three earlier studies that used time-series industry-level data found domestic and foreign product substitution to range from moderately sensitive to relatively insensitive, and then report elasticity estimates from more recent studies. In particular, they conclude that Gallaway, McDaniel, and Rivera (2000) contains the most comprehensive and up-to-date long run estimates which range from 0.53 to 4.83, although other studies found estimates as low as 0.14. McDaniel and Balistreri also review evidence from a cross-section study of trade resistance — the costs of trading goods such as transportation costs — and find estimates that are somewhat larger but still much less than would be implied if domestically produced and imported goods were perfect substitutes. The authors note that the estimates vary widely and caution that the specifications employed in some studies are structurally inconsistent with general equilibrium analysis because they do not include supply-side effects.

A study of the tax responsiveness of foreign direct investment by de Mooij and Ederveen (2003) provides an extensive review of 25 studies that examine international capital mobility. The authors conduct a meta-analysis — a statistical analysis of results from individual studies relating variation in estimates of the elasticities to differences in study characteristics — to determine not only a benchmark estimate of capital's response to taxes, but also a series of alternative central estimates based on differences in tax rates used, the measure of foreign direct investment (FDI) used, and years covered (a sample of studies using 2002 data). To make comparisons across studies employing different specifications, de Mooij and Ederveen transform the coefficients estimated in each study into a uniform semi-elasticity (or tax rate elasticity). They use a semi-elasticity because, as they point out, the elasticity of foreign investment should

Table 8

Evidence on Key Elasticity Assumptions

Elasticity Estimate	Source	Method or Data	Range	Adjusted Range[1]
International product substitution	McDaniel and Balistreri (2002)	Time-series Armington elasticities	0.14 to 4.83	n/a
		Cross-country trade resistance	2 to 6.9	n/a
International portfolio substitution	de Mooij and Ederveen[2] (2003)	Benchmark	–2.4	–1.80 to –1.42[3]
		Alternative tax rates	–9.3 to –1.2	–6.98 to –0.71[4]
		Alternative FDI	–2.0 to 5.1[4]	–1.18 to 3.83[3,4]
		Sample year 2002	–3.7	–2.78 to –2.19[2]
Factor substitution	Chirinko (2002)	Aggregate Investment	0 to 0.3	
		Panel Investment	0.18 to 0. 98	0.18 to 0. 35[5]
		Capital Stock	0 to 1.24	0.3 to 0.7[6]
	Gravelle (2010)	International studies	0.09 to 0.63	0.18 to 0.63[7]

Notes:

[1] Adjusted range provides ranges using adjusted numbers. The adjustments include changes to account for country tax rates, alternative model specifications, and removing outlier and statistically insignificant estimates.

[2] Estimates are reported as negative numbers because they measure the inflow of FDI response to a domestic tax increase.

[3] The lowest tax rate of OECD countries (excluding Ireland, Hungary, and Iceland) was 0.25 in the Slovak Republic, and the highest rate was 0.409 for Japan in 2003.

[4] The positive estimates of responses of inflows of FDI to an increase in domestic tax rates were for FDI measured as mergers and acquisitions, and number of locations. The higher negative estimate was –5.7, adjusted to –4.28 as the top negative range.

[5] This figure reflects adjustments by Chirinko, Fazzari, and Meyer (1999, Section 5).

[6] This range is based on 5 of the 7 studies reviewed.

[7] This range excludes statistically insignificant estimates.

be calculated with respect to the after-tax return, $r(1 - t)$, not the tax rate, t. They find a range of estimates from –3.7 to 5.1 (Table 8).

Because the reported tax semi-elasticity measures from the meta-analysis should be multiplied by $(1 - t)$ to yield an elasticity, Table 8 also shows a range for adjusted estimates.[10] This adjustment presents some difficulties, however. Ideally, the values of t should be those used in the meta-analysis. However, the authors do not provide details on the tax rates used in the studies in their analysis, which vary not only over time (the earliest study included was published in 1984, and the latest study was in 2001), but also among countries. To provide a range of portfolio substitution elasticity estimates from the semi-elasticities estimated in the authors' meta-analysis, those estimates are adjusted using the lowest tax rate of the Organizasion for Economic Co-operation Development (OECD) countries, excluding outliers such as Ireland, Hungary, and Iceland, and the highest OECD tax rate of in 2003.[11] Because all of the studies were conducted prior to 2003, and many during a time when the United States and other countries were just beginning to reduce their corporate tax rates, this range is likely to rely on tax rates that are lower than those used in the studies and thus would overstate the elasticity range. Additionally, relying on data from countries in the OECD and EU, where imported goods may be more likely to be viewed as substitutable, may make the results less applicable to the United States. These difficulties notwithstanding, the adjusted estimates suggest a range of elasticities from –2.78 to 3.84, which are significantly below perfect substitution.

For assumptions on factor substitution elasticities, GM and Randolph both relied on Hamermesh and Grant (1979). Chirinko (2002) provides a review of more recent research on factor substitution elasticities. He reports evidence from studies that used aggregate investment data, panel investment data, and capital stock data. Evidence from aggregate investment data suggests a range from 0 to 0.3. However, Chirinko notes some drawbacks to relying on aggregate data, such as the limited amount of variation relative to industry, or firm level, datasets, simultaneity concerns, capital market frictions, and firm heterogeneity that could bias the estimates. In contrast, studies that relied on panel investment data yield estimates ranging from 0.18 to 0.98. Chirinko points, however, to another study, Chirinko, Fazzari, and Meyer (1999), that corrects for the methodological problems in those panel data studies and finds that the range narrows to 0.18 to 0.35. Last, Chirinko reports a series of estimates based on capital-stock data, which he notes should be less susceptible to transitory variation of investment and may represent long run relations between the capital stock and its determinants. Five of the seven studies from this group find estimates ranging from 0.3 to 0.7, although the other two studies provided estimates as low as zero and as high as 1.24. Gravelle (2010) reviews additional studies that estimate factor substitution elasticities, many of which use data for other countries that were conducted after Chirinko's review. The

[10] De Mooij and Ederveen report $e = dFDI/dt*(1/FDI)$. However, an elasticity with respect to $r(1 - t)$, from an equation of the form $ln(FDI) = Br(1 - t)^e$, would yield $dFDI/dt*[(1 - t)/FDI]$.

[11] Congressional Budget Office (2005) provides a review of corporate tax rates across countries.

estimates from these studies vary from 0.09 to 0.63 for various countries. Dropping the estimate of 0.09, which was not statistically significant, estimates of factor substitution elasticities range from 0.18 to 0.63.

E. Summary Estimate from the Four Studies

It is difficult to determine a central estimate from the four studies of corporate tax incidence in an open economy analyzed in this paper, although in principle one would want to use results from a model that used the central estimates of the critical elasticities from the most reliable empirical studies. Simply averaging estimates across the four studies would not provide an answer that is consistent with the empirical estimates for the critical elasticities discussed above. For example, GM rely on a very low factor substitution elasticity between skilled labor and capital that appears to be implausible, given the empirical evidence on the elasticity of substitution between capital and all labor. Thus, the magnitude of their estimates of the burden borne by capital may be too low. Harberger assumes a high capital intensity in the traded corporate sector, which makes his estimates of the burden on labor very large. Randolph's simulations are restricted to cases of perfect product and portfolio substitution, which appear to be high considered against the empirical evidence.

However, there are two rough approaches that use the reported evidence for the critical elasticities that will provide some information about what a central estimate of the allocation of the corporate tax burden between capital and labor might be. The first, and simplest, is to use the sensitivity analysis provided in GS to identify a central measure from their study. The second approach is more comprehensive, applying basic adjustments to the findings from three of the four studies. That approach takes some of the sensitivity results from GM and from Harberger and applies the suggested effects to Randolph's estimates. As the discussion below shows, although neither approach provides a definitive central estimate from the open-economy studies, both approaches yield quite similar estimates.

Under a factor substitution elasticity of 0.8, and product and portfolio substitution elasticities both equal to three, GS find 27 percent of the tax burden falls on labor and 67 percent falls on capital. The product and portfolio substitution elasticities of three are consistent with the empirical evidence. The empirical evidence, however, suggests that the factor substitution elasticity may be somewhat less than 0.8 — falling in a range between 0.18 and 0.7. In GS's sensitivity estimates, reducing factor substitution elasticities from 1 to 0.8 lowered the share of the burden on capital by 5 percentage points and raised the share of the burden on labor by 6 percentage points. Assuming a reduction in the factor substitution elasticity from 0.8 to 0.6 yields similar changes in burden implies that 33 percent of the corporate tax burden falls on labor and 62 percent falls on capital. More generally, GS's findings suggest that an open economy model that uses elasticity estimates falling within the range suggested by recent empirical studies would find that roughly 40 percent of the corporate tax falls on labor and 60 percent falls on capital. This approach, however, relies solely on the GS study and does not take into account information from the other studies.

A central estimate of the corporate tax burden cannot be derived using the estimates in the other studies directly. However, we can combine information from the other three studies to compare with estimates from GS, using the same assumptions. Specifically, we use results from sensitivity analyses in the GM and Harberger studies to adjust Randolph's estimates.

Randolph's estimates assume a 0.6 factor substitution elasticity and perfect portfolio and product substitution. However, the empirical studies suggest that portfolio and product substitution are imperfect. Recall that, in the GM study, reducing the portfolio substitution elasticity from 300 (essentially perfect substitution) to three increased the burden on capital by 87 percent. Applying this percentage increase to Randolph's capital burden estimate of 32.5 percent yields a rough adjusted estimate, with imperfect portfolio substitution, of about 60 percent of the tax burden falling on capital.

It is difficult to determine the precise nature of the international product substitution and capital mobility assumptions in Harberger's study, because his methodological approach was to allocate the corporate tax burden internationally and then domestically across factors to ensure that the worldwide burden fell entirely on capital. That is, he does not expressly rely on product or portfolio substitution elasticities. However, his subsequent adjustments reflect some extent of international capital immobility and can be applied to Randolph's perfect mobility case as an exercise. This approach implies that about 40 percent of Harberger's original burden attributable to labor is shifted to consumers, and if applied to Randolph's model implies that the corporate tax burden on labor would fall from 73.7 percent to 47.9 percent.

In summary, the adjusted estimates that are consistent with the current empirical evidence on the various elasticities are similar. From GS's sensitivity analyses, an estimate that 62 percent of the corporate tax falls on capital is consistent with parameter values similar to the central values obtained in the empirical literature. Adjusting Randolph's perfect capital mobility and product substitution model using the results of the sensitivity analysis employed by GM also yields an adjusted estimate that about 60 percent of the corporate tax burden falls on capital. Last, a simple exercise that uses product rigidity to adjust Randolph's estimates suggests that 48 percent of the corporate tax burden falls on labor. Taken together, these results, albeit imperfect, suggest that an assumption that 40 percent of the corporate tax burden falls on labor and 60 percent falls on capital is consistent with open-economy models and with the current empirical evidence regarding the appropriate parameter values to be used in those models. This allocation is applicable to the United States since the adjustments ensure a result that reflects the U.S. country size and capital intensities. As noted earlier, the share on domestic capital falls with country size, so smaller countries would be more likely to have more of the corporate tax burden falling on labor.

IV. DRAWBACKS TO OPEN-ECONOMY GENERAL EQUILIBRIUM MODELS

The analysis thus far relies entirely on the open-economy general equilibrium models described previously. These models differ in several ways from the realities of the U.S. and worldwide economy. The constraints in these models suggest that incidence results

derived from these models, even under the most realistic parameter assumptions, may not adequately represent the true incidence of the corporate tax.

Auerbach (2005) provides a detailed theoretical discussion of the incidence of the corporate tax and focuses on some of the problems in the current Harberger-style models used to determine the incidence of the tax. In particular, he notes several scenarios under which corporate shareholders bear more of the burden of the corporate tax than suggested by these models. For example, Auerbach discusses the implications of very slowly adjusting markets on the allocation of the corporate tax burden. If, he notes, capital is extremely slow to adjust, then holders of existing corporate equity will bear a significant burden, and owners of new capital and future generations of workers will bear an additional burden as the adjustment process extends the transition to a new equilibrium. The discussion in this paper focuses on incidence effects in the long run but, as Auerbach suggests, if the short run adjustment is very long, it is worthwhile to note the dynamics of the incidence pattern when preparing a distributional analysis of the effects of the corporate tax. Current open-economy models provide evidence regarding the very long-run equilibrium incidence of the corporate income tax, and do not consider the pattern of incidence over time. Further analysis of the transition from short run incidence to medium and long run incidence would be useful in measuring the distributional effects of the corporate tax.

Auerbach (2005) also discusses the implications for corporate tax incidence of several other important factors that are not included in the general equilibrium models discussed earlier, or considered in this paper. These factors include investment incentives, corporate financial policy (the choice to finance investment using debt or equity), risk, imperfect competition, the choice of organizational form, and managerial incentives.

Harberger (2008, pp. 301–302) notes several general problems with the international aspects of general equilibrium models, specifically their stylistic nature and the assumption (common to all the analyses) that only the United States changes its corporate tax rate:

> … the choice between an open and closed economy is a matter of scenarios, not of reality. I am sure that most academics would agree that the closed-economy result (that 100 percent borne by capital is in the middle, not at the extreme, of the plausible range of outcomes) is the one that would apply in the case of a general worldwide increase or reduction in the rate of the corporation income taxation, and that the closed-economy result is the right one to use in this case. Likewise I hope that most academics would agree that the open-economy model is the right one to use if one country alone changes its CIT [corporate income tax] rate.

There are, in fact, several theoretical and practical concerns in relying on these models to allocate the burden of the current corporate tax. First, these models rely on stylized scenarios of a corporate tax system within a global economy and do not reflect many

aspects of our corporate tax system that could affect the results. The United States has numerous other tax provisions, such as research and experimentation credits, accelerated depreciation, and the production activities deduction, that effectively reduce the corporate tax and mitigate the effects of an increase in the statutory rate. In particular, the U.S. corporate tax system subsidizes debt by allowing deductions for nominal interest. These models are constructed in such a way that any increase in the corporate tax will induce a positive or zero net outflow of capital, but never an inflow. If, however, debt is more mobile than equity, the tax subsidy for debt relative to equity could imply that a tax increase would result in a capital inflow because the higher tax rate would favor debt finance. The higher return to debt-financed investment would provide an incentive for both foreign and domestic investors to shift into U.S. corporate debt. Domestic investors may shift to debt holdings from either U.S. equity or foreign debt holdings. Foreign investors would shift out of foreign equity, foreign debt, or both, into U.S. corporate debt. Thus, if debt is internationally mobile relative to equity, then the result of a corporate tax increase might be an overall reduction in U.S. assets abroad (assuming that U.S. shareholders reduced foreign debt holdings) and an overall increase in foreign investments in the United States.

Grubert and Mutti (1994) examine the consequences of including debt in simulations of corporate-individual tax integration proposals. One integration approach they consider is the allowance of a credit to shareholders for corporate taxes paid in proportion to corporate earnings paid out as dividends. To ensure revenue neutrality, an across-the-board increase in tax rates on capital income would be imposed. In their simulations, Grubert and Mutti find that, despite the higher taxation of capital, a net inflow of capital results. The higher interest rates on debt attract foreign holders, who are exempt from tax on interest, while U.S. shareholders reduce their debt holdings due to the increase in the tax on their interest income. The greater international mobility of debt relative to equity and the tendency for foreign holdings to be concentrated in debt implies the net effect is an inflow of capital. Grubert and Mutti also present a scenario that relies on a lump-sum tax to achieve revenue neutrality, which does not have the effect of introducing a higher tax on individual interest income; this integration reform also results in a (smaller) net inflow of capital.

Second, these models assume that other countries are not changing their corporate tax rates. There is some recent evidence from Altshuler and Grubert (2006) and the Congressional Budget Office (2005) that other countries may respond to changes in U.S. corporate taxes.[12] As noted by Harberger, if countries move in tandem or follow one another in changing their corporate tax rates, the countries together can be modeled much like a closed economy, and the corporate tax burden will tend to be borne by capital.

Last, the open-economy models reviewed earlier assume that the United States is the only country that has a corporate tax or the only country that changes its tax rates. As long as other countries' tax rates remain fixed, these models can estimate the incidence

[12] Randolph (2006) also discusses the implications of such tax competition among countries.

of changing the U.S. corporate tax rate at the margin. However, this assumption has implications for the worldwide allocation of the corporate tax burden. If the economy is closed at the worldwide level, and, assuming the underlying parameters of the world are similar to those assumed in Harberger's original closed-economy model, the burden of worldwide corporate taxes should fall entirely on worldwide capital. Although the results of the models discussed earlier focused on domestic burdens, these models also showed the some of the tax burden falling on foreign factors. For example, both Gravelle and Smetters (2006) and Randolph (2006) estimated the incidence of the U.S. corporate income tax on worldwide capital to be just over 100 percent, and Harberger (2008) assumed the tax incidence on worldwide capital would be 100 percent. Furthermore, these studies find worldwide labor bearing virtually none the tax burden, as foreign labor benefits when domestic labor bears a share of the burden of the corporate income tax.

If every country relied on the same analysis using an open-economy model (for example, by assuming that 40 percent of the burden falls on labor), then the per-country burdens would not aggregate to the result that100 percent of the burden falls on capital worldwide. That is, the burden of the world's corporate taxes should not be assumed to fall 40 percent on labor if the worldwide incidence of the corporate tax is assumed to fall almost entirely on capital.

Consider the problems that arise when looking at two countries — the United States and another country. Assume both countries have a corporate tax. For this example, we use the burden allocation estimates from GS: 21 percent of the burden falls on domestic labor, 72 percent of the burden falls on domestic capital, –19 percent falls on foreign labor, and 30 percent falls on foreign capital. If the foreign country made the same burden assumptions, it would not be adjusting for the effects of the U.S. tax (and vice versa). Moreover, if all countries followed this approach, not only would the allocation of burden from a global perspective be incorrect, the burdens would not sum to the total tax, because the exported tax effects would not be included. These issues suggest that it may not be appropriate to rely solely on the estimates of those models to allocate the burden of worldwide corporate income taxation.

V. AN ALTERNATIVE APPROACH TO ALLOCATING CORPORATE TAX INCIDENCE

A different way of thinking about the incidence of the corporate tax draws from research on the incidence of the property tax, where similar issues of competing tax systems arise. The so-called "new view" of the property tax (Mieszkowski, 1972) considers the impact of a system of local taxes from the perspective of the entire country. Until this work, economists had generally assumed that the burden of the property tax was shifted to consumers as an excise tax on all housing services. Under the new view, nationwide use of the property tax imposes a national burden that falls on reproducible capital, with differential property taxes across jurisdictions inducing additional effects similar to those of excise taxes, which alter consumer prices or returns to immobile factors. Mieszkowski (1972, p. 74) was quick to note that there was little conflict between

the view that property taxes are excises and the suggestion that the basic effect of the property tax is to reduce the yield from real capital "if it is properly recognized that the global (nationwide) effects of the tax are quite different than the partial effects of a single city, or groups of cities."[13] In his model, 100 percent of the average national property tax rate falls on capital, and there are also excise taxes and subsidies that vary across jurisdictions because of differentials about the average national tax rate.

There are some similarities between the treatment of jurisdictional tax differences for property taxes within a nation and worldwide corporate tax differences across nations. Based on this similarity, it may be that analysis of corporate tax incidence would benefit from applying the new view's notion of differential tax rates, treating countries as states. Under this type of analysis, the worldwide average tax on capital would fall largely on capital (assuming the worldwide parameters are similar to those assumed in Harberger's original closed-economy model). Deviations from that average would represent differential profit taxes and subsidies. That difference could be allocated based on the incidence assumptions from the open-economy models that estimate changes in corporate taxes, which are, in effect, what the profit taxes and subsidies ultimately represent. This approach could be justified as a different scenario, as suggested by Harberger above in differentiating between analysis of a worldwide tax change and a single country's tax change. The approach could also be justified if countries are believed to move in tandem.

Table 9 shows the allocation between capital and labor of corporate taxes, using this allocation method. Estimates rely on a GDP-weighted average of OECD country tax rates. Although the OECD countries do not represent the rest of the world, they provide a large base for the illustration of this approach. For example, the U.S. corporate tax rate (including federal and state taxes) was 39.25 percent in 2008. With the average OECD tax rate at 33.4 percent, 85.0 percent of the U.S. tax would fall entirely on capital. U.S capital could not escape that portion of the corporate tax by going overseas. The burden of the remaining differential profits taxes about the worldwide average would be allocated according to estimates from the open-economy models, which in the case of the United States is assumed to be 60 percent on capital and 40 percent on labor. This illustration uses this same 60/40 split for each country. However, ideally the shares of the burden falling on capital and labor would be estimated separately for each country, allowing those models to be calibrated for their respective country size and capital intensities. (The analysis tends to overstate capital burdens, because no other country has a share of the worldwide capital stock as large as the 30 percent share of the United States.) In the U.S. example, 60 percent of the remaining 15 percent of the U.S. tax would be allocated additionally to capital, yielding a nine percent residual capital tax from the excise effect. Thus the tax burden borne by total U.S. capital would be

[13] Zodrow (2000) also provides a review of the new view of property tax incidence. Gravelle (2007) discusses the implications of using the new view for estimating incidence.

Table 9

Burden Allocations of Corporate Taxes Across the OECD Countries, 2008

	Share of Corporate Tax Burden (%)			
	Corporate Tax Rate[1]	GDP-Weighted OECD Corporate Tax Rate = 33.4%		
		Total Capital	Labor	Capital Through Residual[2]
Australia	30	105	–5	–7
Austria	25	113	–13	–20
Belgium	33.99	99	1	1
Canada	33.50	100	0	0
Czech Rep.	21	124	–24	–35
Denmark	25	113	–13	–20
Finland	26	111	–11	–17
France	34.43	99	1	2
Germany	30.18	104	–4	–6
Greece	25	113	–13	–20
Hungary	20	127	–27	–40
Iceland	15	149	–49	–74
Ireland	12.50	167	–67	–100
Italy	27.50	109	–9	–13
Japan	39.54	94	6	9
Korea	27.50	109	–9	–13
Luxembourg	30.38	104	–4	–6
Mexico	28	108	–8	–12
Netherlands	25.50	112	–12	–19
New Zealand	30	105	–5	–7
Norway	28	108	–8	–12
Poland	19	130	–30	–45
Portugal	26.50	110	–10	–16
Slovak Rep.	19	130	–30	–45
Spain	30	105	–5	–7
Sweden	28	108	–8	–12
Switzerland	21.17	123	–23	–35
Turkey	20	127	–27	–40
U.K.	28	108	–8	–12
U.S.A.	39.25	94	6	9

Notes:

[1] Tax rates are the top statutory rates, federal plus provincial/state, for 2008.

[2] The share of the differential (tax or subsidy) that is allocated to capital. Because the differential can be below or above the worldwide average, the allocation can be negative or positive.

Sources: Analysis of data from OECD corporate tax rates, http://www.oecd.org/tax/taxpolicyanalysis/oecdtaxdatabase.htm#C_Corporate Capital, and GDP values from OECD Annual National Accounts, http://www.oecd.org/std/nationalaccounts/

94 percent. Countries that have corporate tax rates lower than the worldwide average show more than 100 percent of the burden falling on capital because the benefit of the relatively low corporate tax rate they provide does not accrue entirely to capital, but also to labor. Effectively, high corporate-tax countries export a burden to capital and import a burden on labor.

VI. CONCLUSION

This review suggests that adding open economy considerations to the standard general equilibrium model of tax incidence does not by itself imply that most of the burden of the corporate tax is shifted from capital to domestic labor. Instead, the additional assumptions of highly internationally mobile capital and highly substitutable domestic and imported products are needed to ensure that the majority of the tax is borne by labor. Relaxing the assumptions of perfect capital mobility or highly substitutable domestic goods and imports changes the burden allocation to indicate that, even in an open economy, a majority of the corporate tax burden, perhaps 60 percent, is borne by capital.

In addition, these empirically-based general equilibrium models, while extensively developed, cannot fully reflect important aspects of the U.S. corporate tax or the nature of global interactions with other countries. Existing evidence of the linkage between U.S. tax policy and that of other countries suggests, at least with regard to the burden of the corporate income tax, that the United States operates in more of a closed economy than these models assume, even with their the imperfect international mobility assumptions, again suggesting domestic capital bears the bulk of the corporate tax.

These models are designed to measure changes in the corporate tax and may not be appropriate for allocating the full amount of an existing tax. Given that the worldwide corporate tax should fall on worldwide capital, an alternative approach to determining the incidence of the current corporate tax may be to allocate the worldwide average to domestic capital and to allocate country deviations from that average as changes in the corporate tax, using the open-economy model's estimates. Under this approach, more than 90 percent of the burden of the corporate tax should be allocated to domestic capital.

This analysis demonstrates that minor additions of rigidity to standard open-economy models in the forms of immobile capital or imperfect product substitution can result in capital bearing a major portion of the burden of the tax. The open-economy assumption thus does not necessarily lead to the conclusion that domestic labor bears more of the burden of the corporate tax than does domestic capital.

ACKNOWLEDGMENTS AND DISCLAIMERS

The views expressed here are those of the author and should not be interpreted as those of the Congressional Budget Office.

REFERENCES

Altshuler, Rosanne, and Harry Grubert, 2006. "Governments and Multinational Corporations in the Race to the Bottom." *Tax Notes* 110 (8), 979–992.

Armington, Paul S., 1969. "A Theory of Demand for Products Distinguished by Place of Production." *International Monetary Fund Staff Papers* 16 (1), 159–176.

Atkinson, Anthony B., and Joseph E. Stiglitz, 1980. *Lectures on Public Economics.* New York: McGraw-Hill.

Auerbach, Alan J., 2005. "Who Bears the Corporate Tax? A Review of What We Know." In Poterba, James M. (ed.), *Tax Policy and the Economy, Volume 20,* 1–40. National Bureau of Economic Research, Cambridge, MA.

Baron, David P., and Robert Forsythe, 1981. "Uncertainty and the Theory of Tax Incidence in a Stock Market Economy." *International Economic Review* 22 (3), 567–576.

Batra, Raveendra N., 1975. "A General Equilibrium Model of the Incidence of Corporation Income Tax Under Uncertainty." *Journal of Public Economics* 4 (4), 343–360.

Bhatia, Kul B., 1981. "Intermediate Goods and the Incidence of the Corporation Income Tax." *Journal of Public Economics* 16 (1), 93–112.

Chirinko, Robert S., 2002. "Corporate Taxation, Capital Formation, and the Substitution Elasticity Between Labor and Capital." *National Tax Journal* 55 (2), 339–355.

Chirinko, Robert S., Steven M. Fazzari, and Andrew P. Meyer, 1999. "How Responsive Is Business Capital Formation to Its User Cost?: An Exploration With Micro Data." *Journal of Public Economics* 74 (1), 53–80.

Congressional Budget Office, 2005. *Corporate Income Tax Rates: International Comparisons.* Congressional Budget Office, Washington, DC.

Cragg, John G., Arnold C. Harberger, and Peter Mieszkowski, 1967. "Empirical Evidence on the Incidence of the Corporation Income Tax." *Journal of Political Economy* 75 (6), 811–822.

de Mooij, Ruud A., and Sjef Ederveen, 2003. "Taxation and Foreign Direct Investment: A Synthesis of Empirical Research." *International Tax and Public Finance* 10 (6), 673–693.

Gallaway, Michael P., Christine A. McDaniel, and Sandra A. Rivera, 2000. "Long-Run Industry-Level Estimates of U.S. Armington Elasticities." Office of Economics Working Paper No. 2000-09-A. U.S. International Trade Commission, Washington, DC.

Gravelle, Jane G., 2009. "Corporate Income Tax: Incidence, Economic Effects, and Structural Issues." In Head, John G., and Richard Krever, (eds.) *Tax Reform in the 21st Century: A Volume in Memory of Richard Musgrave*, 355–384. Kluwer Law International BV, Netherlands.

Gravelle, Jane G., 2010. "Economic Effects of Investment Subsidies." In Claus, Iris, Norman Gemmell, Michelle Harding, and David White (eds.), *Tax Reform in Open Economies: International and Country Perspectives,* 38–59. Edward Elgar Publishing Ltd., Northampton, MA.

Gravelle, Jane G., and Laurence J. Kotlikoff, 1989. "The Incidence and Efficiency Costs of Corporate Taxation When Corporate and Noncorporate Firms Produce the Same Good." *Journal of Political Economy* 97 (4), 749–780.

Gravelle, Jane G., and Kent A. Smetters, 2006. "Does the Open Economy Assumption Really Mean That Labor Bears the Burden of a Capital Income Tax?" *The B.E. Journal of Economic Analysis & Policy, Advances in Economic Analysis and Policy* 6 (1), Article 3.

Gravelle, Jennifer, 2007. "Who Pays Property Taxes? A Look at the Excise Tax Effects of Property Taxes Across the States." In *Proceedings of the One Hundredth Annual Conference on Taxation,* 94–97. National Tax Association, Washington, DC.

Grubert, Harry, and John Mutti, 1985. "The Taxation of Capital Income in an Open Economy: The Importance of Resident-Nonresident Tax Treatment." *Journal of Public Economics* 27 (3), 291–309.

Grubert, Harry, and John Mutti, 1994. "International Aspects of Corporate Tax Integration: The Role of Debt and Equity Flows." *National Tax Journal* 47 (1), 111–133.

Hamermesh, Daniel S., and James S. Grant, 1979. "Econometric Studies of Labor-Labor Substitution and Their Implications for Policy." *Journal of Human Resources* 14 (4), 518–542.

Harberger, Arnold C., 1962. "The Incidence of the Corporation Income Tax." *Journal of Political Economy* 70 (3), 215–240.

Harberger, Arnold C., 1995. "The ABCs of Corporate Tax Incidence: Insights into the Open-Economy Case." In *Tax Policy and Economic Growth*, 51–73. American Council for Capital Formation, Washington, DC.

Harberger, Arnold C., 2008. "Corporate Tax Incidence: Reflections on What is Known, Unknown, and Unknowable." In Diamond, John W., and George R. Zodrow (eds.), *Fundamental Tax Reform: Issues, Choices, and Implications,* 283–308. MIT Press, Cambridge, MA.

Krzyzaniak, Marian, and Richard A. Musgrave, 1963. *The Shifting of the Corporation Income Tax.* Johns Hopkins Press, Baltimore, MD.

McDaniel, Christine A., and Edward J. Balistreri, 2002. "A Discussion of Armington Trade Substitution Elasticities." Office of Economics Working Paper No. 2002-02-A. U.S. International Trade Commission, Washington, DC.

McLure, Charles E., Jr., 1975. "General Equilibrium Incidence Analysis: The Harberger Model after Ten Years." *Journal of Public Economics* 4 (2), 125–161.

Mieszkowski, Peter, 1972. "The Property Tax: An Excise Tax or a Profits Tax?" *Journal of Public Economics* 1 (1), 73–96.

Parai, Amar K., 1988. "The Incidence of Corporate Income Tax Under Variable Returns to Scale." *Public Finance* 43 (3): 414–424.

Parai, Amar K., and Munir A. S. Choudhary, 1992. "Imperfect Labor Mobility and Corporate Tax Incidence." *International Economic Journal* 6 (3), 75–82.

Randolph, William C., 2006. "International Burdens of the Corporate Income Tax." CBO Working Paper No. 2006-09. Congressional Budget Office, Washington, DC.

Ratti, Ronald A., and Parthasarathi Shome, 1977a. "On a General Equilibrium Model of the Incidence of the Corporation Tax under Uncertainty." *Journal of Public Economics*, 8 (2), 233–238.

Ratti, Ronald A., and Parthasarathi Shome, 1977b. "The Incidence of the Corporation Income Tax: A Long-Run, Specific Factor Model." *Southern Economic Journal*, 44 (1), 85–98.

Ratti, Ronald A., and Parthasarathi Shome, 1977c. "The General Equilibrium Theory of Tax Incidence under Uncertainty." *Journal of Economic Theory*, 14 (1), 68–83.

Shoven, John B., 1976. "The Incidence and Efficiency of Taxes on Income from Capital." *Journal of Political* Economy 84 (6), 1261–1283.

Zodrow, George R., 2000. "Reflections on the New View and the Benefit View of the Property Tax." In Oates, Wallace E. (ed.), *Property Taxation and Local Government Finance*, 79–111. Lincoln Institute of Land Policy, Cambridge, MA.

Zodrow, George R., and Peter Mieszkowski, 1986. "The New View of the Property Tax: A Reformulation." *Regional Science and Urban Economics* 16 (3), 309–327.