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**Corporate Tax Incidence:
Review of General Equilibrium Estimates and Analysis**

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Abstract

This paper reviews the current evidence on the incidence of the corporate tax from Harberger-type general equilibrium models, with special attention to the open economy. The analysis identifies the major drivers of the results from open-economy models and compares estimates from four major studies that have examined corporate tax incidence in an open economy. The studies vary in the assumptions of critical elasticities, and the variations account for differences in the reported estimates. Adjusting the estimates from the studies to reflect central empirical estimates of key elasticities suggests that capital bears the majority of the corporate tax burden. This paper details drawbacks to the use of these models, such as their focus on the long-run when the adjustment from the short-run could be very long.

The paper also presents an alternative method for allocating the corporate tax burden. The proposed method draws on the new view of incidence of the property tax and, in a similar fashion, distinguishes between the global effects of corporate taxes and excise effects that vary among nations. In this view, capital bears the full burden of the worldwide average corporate tax. Deviations from the average worldwide corporate tax are allocated according to the central estimate derived from the review of the general equilibrium models of corporate tax incidence. This alternative method suggests that, even in an open economy, capital could bear virtually the entire tax burden and that the open-economy assumption is not sufficient to shift the burden of the corporate tax from capital to labor.

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 none of the economic sectors were involved in trade with other 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. Even with well-developed open-economy models, there are several issues in relying on this form 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 U.S. tax.

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 the 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, the corporate tax incidence can be viewed from a global perspective, taking into account excise effects that result from differences among countries in their corporate tax rates.

¹ Although widely known as the “new” view of property tax incidence, this view was first developed by Mieszkowski (1972).

Early Analysis of Corporate Incidence

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 tax. 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 estimate 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. Ultimately, because of the non-robust results the empirical studies offered, the research community appeared to have abandoned the empirical line of research in favor of Harberger's model.

Harberger's model employed a drastically different approach to the direct empirical analysis by constructing a theoretical two-sector general equilibrium model to 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

² Auerbach (2005), Jane Gravelle (2009), and McLure (1975) provide more details on the early developments 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 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 shares) if the factor substitution elasticity within the taxed sector is greater than the product substitution elasticity between sectors. Third, the higher the 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 specifications and his estimates for the values of the relevant elasticities, Harberger concluded that the majority of the tax burden fell on capital.

Following the introduction of Harberger's model, numerous studies made further refinements and adjustments to the original model. Although those studies sometimes yielded different results, none of the studies ruled out the possibility that, under largely reasonable assumptions, capital would bear a large share of the corporate tax burden. (See the Appendix for more details on the original Harberger model and a review of some of the early extensions made to the model.)

Open-Economy Models of Corporate Tax Incidence

Though even with those additional adjustments the basic Harberger model continued to suggest that capital largely bore the burden of the corporate tax, the economy was still assumed to be closed under the variations. Introducing an open economy into the Harberger model allows for the possibility of capital to flow abroad, which could shift some of the burden from the now more mobile factor—capital—to the immobile factor—labor. At the extreme, for example, if a country is small and capital is perfectly mobile in a one-good economy, labor bears 100 percent of the burden. As global interactions and large multinational corporations grew, it became clear that a comprehensive analysis should assume an open-economy framework to determine how much of the burden is shifted from capital to labor.

This analysis considers four major studies that use a general equilibrium model similar to Harberger’s model within an open economy framework. The results from these studies vary and have led to uncertainty over assumptions about the long run allocation of the corporate income tax burden.

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 product substitution between the taxed and untaxed sector, factor substitution within sectors, and 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: mobility of capital across nations, mobility (or substitution) of products between countries, and the size of countries. Two assumptions are as in the closed-economy model: factor substitution within sectors and relative factor intensities in different sectors of the economy.³ Table 1 summarizes the effects of these open-economy assumptions, and the following discussion describes the underlying economic forces.

Table 1: Major 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	↓	↑

³ 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.

International Mobility of Capital. If capital is mobile (there is perfect portfolio substitution) across borders, the corporate tax reduces the return to capital in the domestic corporate sector, driving 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 to the tax. Immobile labor bears a larger portion of the tax as the increased return to the remaining capital reduces 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.

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. Domestic buyers are less willing to substitute the foreign product for the domestic 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 increased demand for their version of the products. This product rigidity effectively makes the country more like a closed economy.

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 and prices 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, it 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 amount of the tax that capital will bear, under perfect international capital and product mobility, is equal to the country's world share of output.

Factor Substitution. The less that 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 wages down. For example, in the closed economy, as the demand for capital falls and the taxed sector wishes to reduce its excess capital, if it and the other sectors are unwilling to accept more labor in substitution 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 wages down and increasing the return to capital. As a result, because it is the immobile and nonsubstitutable factor, labor will bear a larger burden.

Factor Intensities. Factor intensities affect the magnitude of the 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 the 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 relative to the size of the tax to absorb that cost through decreased wages, 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.

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 shift 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 for the five major factors and the

main results from each of the four studies. It then compares these results and provides explanations for the source of the differences.

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:

- 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.)
- International product substitution is imperfect with an elasticity of 3.
- The country is large and affects factor prices in world market.
- The nontraded (noncorporate) sector is more capital-intensive than the export sector.
- 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 (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 return abroad.

Table 2: Corporate Income Tax Burden

Capital Mobility Elasticity	0	0.4	1.0	3.0	300
Type of Capital					
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), p. 301.

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 as follows.

- International capital mobility (portfolio substitution) is either imperfect or perfect, with elasticities of 0.1, 3, and 100. (100 is effectively equivalent to perfect substitution.⁴)
- International product substitution is either imperfect or perfect, with elasticities of 1, 3, and 100. (100 is effectively equivalent to perfect substitution.)
- The country is large and affects factor prices in the world market.
- The nontraded noncorporate sector is more capital intensive than the corporate sectors (as assumed in GM).
- The traded corporate sector and nontraded corporate sector are both labor-intensive (similar to GM), but allow for sensitivity variations in capital intensity. The factor substitution elasticities vary from 0.8, 1, 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, domestically produced capital goods. 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

⁴ 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.

capital and products are highly substitutable internationally, GS find domestic capital's share of the tax burden is 35 percent. As noted earlier in the discussion of the effects of the size of a country, 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. In the case of perfect international substitution, 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 exported abroad to foreign capital and, generally, foreign labor benefits from the increased capital flowing abroad.

Table 3: Corporate Tax Burden with Unitary Factor Substitution

Product Substitution Elasticity	Burden that Falls on Domestic Labor			Burden that Falls on Domestic Capital		
	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 = capital mobility elasticity.

Source: Gravelle and Smetters (2006), p. 25.

Reducing the mobility of capital greatly changes the domestic allocation of the incidence 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 that elasticity to 3 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 borne by domestic capital but has large impacts on the share borne by domestic labor. Reducing the product substitution elasticity to 3 changes the allocation to 55 percent on domestic labor and 36 percent on domestic capital. At a product substitution elasticity of 1, 21 percent of the burden falls on domestic labor

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

In addition to performing sensitivity analysis on international product and capital mobility, GS also provide a series of sensitivity results for factor substitution elasticities and capital intensities. These results are shown in Table 4. As can be seen, 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 3. 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 3, 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.

Table 4: Factor Substitution Sensitivity Effect on Burden of Corporate Tax.

	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		
Product Substitution Elasticity	CME 0.1	CME 3	CME 100	CME 0.1	CME 3	CME 100	CME 0.1	CME 3	CME 100	CME 0.1	CME 3	CME 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 = Capital Mobility Elasticity.

Source: Gravelle and Smetters (2006), p. 28.

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 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.
- International product substitution is perfect.⁵
- The size of the country varies under different scenarios, but world factor prices are assumed not to be fixed.
- The corporate sector is more labor-intensive than noncorporate sectors are (relying on the same capital-intensity assumptions used by GS).
- The factor substitution elasticity is 0.6, but Randolph notes that changing that value to 1 does not change the results significantly.

Table 5 summarizes some of the major results from Randolph's analysis. His illustrations with perfect international mobility of capital and products confirm the standard effect of the 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

⁵ Although Randolph 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.

tax burden. Randolph’s second set of results (in row 2 and row 3) illustrates the sensitivity to assumptions about capital intensity.

Table 5: Effect of Country Size and Capital Intensity on the Allocation of Corporate Income Tax Burden

Assumptions	Share Burden on Domestic Labor	Share Burden on Domestic Capital
Perfect product substitution (corporate taxable sectors 1 and 2 have equal capital intensity). 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. Domestic country share of output is 70 percent.	32.5%	72.7%

Source: Randolph (2006), pp. 59 and 61.

Recall that Randolph’s first two sectors were traded corporate sectors that varied in the substitutability of their products, with the second sector having fewer traded products. Initially, he assumes that each traded corporate sector is equally capital intensive. Increasing capital intensity in the less-traded sector allows the bulk of the tax to be imposed in a sector with less capital mobility, reducing the ability to shift tax to labor. If, instead, capital intensity is increased in the more traded sector, then most of the tax would be imposed in an area with great capital mobility, allowing domestic capital to escape the tax by flowing abroad, and 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 (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 exhibit similar results (the less open the economy, the more the burden falls on capital), they should not be taken as the

same as allowing for differences in capital substitution elasticity, as these factors work differently within the models than do variations in country size. Specifically, with perfect capital and perfect product substitution, country size has predictable effects: Generally the share of burden falling on domestic capital will follow 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.

Harberger (2008). Harberger does not explicitly provide a detailed model of a two-country regime with perfect capital and product substitution.⁶ However, those assumptions do not need to be imbedded within the analysis to consider a perfect capital mobility scenario. Instead, in his exercise, Harberger derives the 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 on two factors—capital and labor—and the agricultural sector includes land, as well. Harberger's key model assumptions are as follows.

- International capital mobility (portfolio substitution) is perfect.
- International product substitution is perfect.
- The country is large and affects factor prices in the world market.
- In a departure from the previous studies, the nontraded noncorporate sector is less capital intensive than the corporate sectors, and one quarter of the total capital is allocated to the corporate traded sector.
- Cobb-Douglas production functions provide unitary factor substitution elasticities.

⁶ Harberger's 2008 paper is uses his 1995 open-economy model but takes into account the changes in the prices of products in other sectors. For a detailed discussion of the effect of this adjustment, see Appendix: Other Studies, in Randolph (2006).

Assuming perfect substitution of capital and products, Harberger’s “illustrative incidence exercise” results in 130 percent of the corporate tax burden falling on domestic labor. (See Table 6.) Harberger’s exercise assumes that the worldwide burden of the corporate tax falls on all capital. His exercise is set up to ensure 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 labor.

Table 6: Results of Harberger’s Illustrative Incidence

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), pp. #295 and 299.

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 7: Summary of Studies' Assumptions

Assumption	Grubert and Mutti	Gravelle and Smetters	Randolph	Harberger
Imperfect Capital Mobility	Yes	Yes	No	No
<i>Sensitivity Analysis</i>	Yes	Yes	No	No
Imperfect Product Substitution	Yes	Yes	No ^a	Limited ^b
<i>Sensitivity Analysis</i>	No	Yes	No	No
Large Country	Yes	Yes	Yes	Yes
<i>Sensitivity Analysis</i>	No	No	Yes	No
Taxed Corporate Sector More Labor Intensive	Yes	Yes	Yes	No
<i>Sensitivity Analysis</i>	No	Yes	Yes	No
Factor Substitution Between 0.6 and 1	No	Yes	Yes	Yes
<i>Sensitivity Analysis</i>	No	Yes	Limited ^c	No

^a Although there is a sector with imperfect product substitution, the results in Randolph's model are not affected by this sector's international substitution. ^b Although Harberger did not make an explicit assumption about elasticity values, an adjustment was made for manufacturing factor rigidity. ^c Randolph tested another factor substitution value but did not provide results.

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 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 portfolio substitution elasticities are set equal to 3 (that is, they are imperfect). Under these assumptions, GM estimate 26.1 percent of the tax burden falls on domestic capital and GS find 67 percent falling on domestic capital.

Those estimates are drastically different: GM estimates generally show a much lower burden of the tax falling on capital than GS. Although the two estimates reflect similar assumptions for four of the

major drivers, they differ in their assumptions about the factor substitution elasticity. The GS estimate noted above is based on their 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 0.05 is roughly equivalent to nearly fixed factors for capital and skilled labor. In this case, as capital flows abroad, the taxed sector needs to reduce the quantity of skilled labor by almost the same amount—greatly driving down the demand for labor relative to capital, depressing wages, and shifting significant shares of the burden of the tax to domestic labor.

A comparison of GS and Randolph, however, reveal that small differences in factor substitution elasticities may not matter, 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 the very low factor substitution elasticity had a drastic effect on the estimate of the share of the burden falling on domestic capital, the lower value in Randolph does not affect the results. When there is perfect international mobility of products and capital, small differences in the factor substitution elasticities (Randolph's assumption of 0.6 compared to GS's

assumption of 0.8) are dominated by the assumptions of high international substitution elasticities. In contrast, the large difference between the moderate factor substitution assumed by GS (0.6) and the extremely low value GM assume (0.05) drives the results when the 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.

Factor Intensities

Although GS and Randolph derive the same estimates, under perfect product and portfolio substitution assumptions, 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 intensity 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. Randolph's adjustments result in large changes. Randolph splits the corporate traded sector into a more traded sector and a less traded sector. 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 those estimates can be explained by the type of adjustment that is made to relative capital intensities. 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 allows for the bulk of the tax to be imposed in a sector with less product substitution and capital mobility, reducing the ability to shift 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 magnitude of a given tax that labor in that sector will 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 conflicting forces that net out to little change. GS change relative capital intensities by equalizing the intensity 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 conflicting forces can cancel each other out, resulting in little change to the overall allocation of the tax burden. This aspect can be seen more clearly under 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 3). In this case, GS find that equalizing capital intensities changes the share of burden falling on domestic labor and capital from 21 percent and 72 percent to 17 percent and 85 percent, respectively (not included 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, because of the immobile capital and imperfectly substitutable products—thus reducing the impact of the traded corporate sector’s higher capital intensity on the tax burden to labor. This weak increase in the burden on labor, paired with the strong effect from the nontraded noncorporate sectors in reducing the burden on labor, results in a net reduction in the tax burden borne by labor.

Assumptions about capital intensity in various sectors 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 1.⁷ With perfect product and portfolio

⁷ Recall that Randolph assumes a factor substitution elasticity of 0.6 but because of perfect international mobility, it does not affect the results significantly.

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 finds 130 percent of the tax burden falling on domestic labor and only 14 percent of the tax burden on domestic capital.

Harberger and GS differ in their assumptions about relative factor intensities. Harberger's estimates assume much larger capital intensity in the traded corporate sector than GS and Randolph.⁸ 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, this produces a large tax (simply from the large amount of capital in the taxed sector) that 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 change must flow through a drop in wages.

In summary, the studies 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 differ from those in the GS and Randolph studies because of differences in relative capital intensities in the various sectors.

⁸ Harberger 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. Harberger's 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, $(0.25 \cdot 0.25) / (0.2 \cdot 0.75 + 0.25 \cdot 0.25)$); 0.45 for the nontraded corporate sector; and 0.21 for the noncorporate nontraded sector. 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.

Evidence for Elasticity Assumptions

The studies above show the sensitivity of estimates of the corporate tax burden in an open economy to the underlying assumptions. Only one key assumption was consistent throughout all four studies: that the models apply to a large country. The other major drivers in these models—factor substitution, capital mobility, international product substitution, and relative factor intensities—vary greatly across some of the studies.

Harberger's study is the only study that assumed the traded corporate sector was more capital-intensive than the nontraded noncorporate sector. He does not provide information in his study about the source of his 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 determining the relevant elasticities, which measure behavioral responses to specific changes in prices while attempting to hold all other factors constant. Even if establishing the exact measure of the relative capital intensities is not simple, the large stock of noncorporate owner-occupied housing in the United States argues for a traded corporate sector that is less capital intensive than the nontraded noncorporate sector.

Certainly, resolving the values of elasticities that should be used is 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.

Table 8: Evidence on Key Elasticity Assumptions

Elasticity Estimate	Source	Method or Data	Range	Adjusted range ^a
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 ^b (2003)	Benchmark	-2.4	-1.80 to -1.42 ^c
		Alternative tax rates	-9.3 to -1.2	-6.98 to -0.71 ^c
		Alternative FDI	-2.0 to 5.1 ^d	-1.18 to 3.83 ^{c,d}
		Sample year 2002	-3.7	-2.78 to -2.19 ^b
Factor Substitution	Chirinko (2003)	Aggregate Investment	0 to 0.3	
		Panel Investment	0.18 to 0.98	0.18 to 0.35 ^e
		Capital Stock	0 to 1.24	0.3 to 0.7 ^f
	Jane Gravelle (2010)	International studies	0.09 to 0.63	0.18 to 0.63 ^g

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

^bEstimates are reported negative because they measure inflow of FDI response to a domestic tax increase.

^cThe lowest tax rate of OECD countries (excluding Ireland, Hungary, and Iceland) was 0.25 in the Slovak Republic, and the highest rate was for Japan at 0.409 in 2003.

^dThe 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 top negative range.

^eAdjusted by Chirinko, Fazzari, and Meyer (1999, Section 5)

^fBased on 5 of the 7 studies reviewed

^gExcluding statistically insignificant estimates

McDaniel and Balistreri (2002) review econometric studies estimating Armington elasticities—a constant elasticity of substitution specification for trade substitution elasticities derived from Armington (1969). 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 note a study by Gallaway, McDaniel, and Rivera (2000) as containing the most comprehensive and up-to date-estimates; that study reported long-run estimates ranging 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, and find the range of those estimates to be higher but still inelastic. 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 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 coefficients of each study into a uniform semi-elasticity (or tax rate elasticity). They use a semi-elasticity because, as they point out, the true elasticity of foreign investment should be with respect to the after-tax return, $r(1-t)$, not the tax rate, t , as done in their calculations. They find a range of estimates: from -3.7 to 5.1 (see Table 8).

Because the reported elasticity measures from the meta-analysis should be multiplied by $(1-t)$, Table 8 also shows a range for adjusted estimates.⁹ This adjustment presents some difficulties, however. Ideally, the choice of t should be derived using the meta-analysis results of the studies. However, the authors do not provide details on the tax rates used by the studies, 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, including panel data from OECD and EU countries. To provide a range of portfolio substitution elasticity estimates from the semi-elasticities determined by the authors’ meta-analysis, those estimates are adjusted using the lowest tax rate of OECD countries, excluding outliers such as Ireland, Hungary, and Iceland, and the highest tax rate of OECD in 2003.¹⁰ 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

⁹ de Mooij and Ederveen report $e = dFDI/dt*(1/FDI)$. But an elasticity with respect to $r(1-t)$, from an equation of the form $\ln(FDI)=Br(1-t)^e$, would yield $dFDI/dt*[(1-t)/FDI]$

¹⁰ See Congressional Budget Office (2005) for a review of corporate tax rates across countries.

thus would overstate the elasticity range. These difficulties notwithstanding, the adjusted estimates suggest a range of elasticities from -2.78 to 3.84.

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 that these elasticity estimates may 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. Jane 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 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, elasticities range between 0.18 and 0.63.

Summary Estimate from Major Studies

It is difficult to determine a central incidence value from the four studies of corporate tax incidence in an open economy. Results from a model that used the central estimates of the critical

elasticities from the most reliable empirical studies would be preferable. 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 does not appear to be supported by the empirical evidence. Thus, the magnitude of their estimates of the burden borne by capital may be too low. Harberger assumes high capital intensity in the traded corporate sector, which makes his estimates of the burden on labor very large. Randolph's illustrations are restricted to cases of perfect product and portfolio elasticities, 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 on 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 of the burden distribution to Randolph's estimates. As the discussion below shows, although neither approach provides an all-inclusive and advanced 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 3, GS find 27 percent of the tax burden falls on labor and 67 percent falls on capital. The product and portfolio substitution elasticities of 3 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 on capital by 5 percentage points and raised 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: An adjusted estimate consistent with a factor substitution elasticity of 0.6 shows 33

percent of the corporate tax burden falling on labor and 62 percent falling 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 and apply that calculation to 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 3 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 international product substitution and capital mobility assumptions in Harberger's study, because his methodological approach was to allocate burden internationally and then domestically across factors to ensure worldwide burden fell entirely on capital. That is, he does not expressly rely on product or portfolio substitution elasticities. However, his rigidity adjustments reflect some aspect of international capital immobility and can be applied to Randolph's perfect mobility case as an exercise. This analysis provides a scenario in which about 40 percent of Harberger's original burden attributable to labor is instead shifted to consumers, and that effect is reflected within the parameter assumptions of Randolph's model. This illustration shows the corporate tax burden on labor falling from 73.7 percent to 47.9 percent.

In summary, the separate estimates that align with the current evidence on underlying assumptions are similar. From GS's sensitivity analyses, an estimate of 62 percent of the corporate tax falling on capital relies on parameter estimates similar to the central values reported empirically. Adjusting Randolph's perfect capital mobility and product substitution model with the sensitivity analysis employed by GM also yielded an adjusted estimate of about 60 percent of the corporate tax burden falling on capital. Last, a simple exercise that provided a scenario of product rigidity to adjust Randolph's estimates showed 48 percent of the corporate tax burden falling 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 for those models.

Drawbacks to Open-Economy General Equilibrium Models

The prior analysis relies entirely on the open-economy general equilibrium models described previously. These models differ in several ways from the realities of our own and the 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 problems in the current Harberger-style models that constrain the allocations of the corporate tax. In particular, he notes several scenarios that may indicate that corporate shareholders bear more of the burden of the corporate tax than owners of all capital and labor. 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 moves to equilibrium. This discussion focuses on the different incidence effects in the long run rather than in the short run and, 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. The current open-economy models provide evidence of the very long-run equilibrium incidence of the corporate income tax, and do not take into account the patterns 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 also discusses the implications for corporate tax incidence of other factors that are not included in the general equilibrium models discussed earlier. Those factors include investment incentives, corporate financial policy (the choice to finance via debt or equity), risk, imperfect competition, the choice of organizational form, and managerial incentives. Although the issues Auerbach presents are important, it is the focus of this paper to address the international aspects of these models, leaving aside compositional and dynamic concerns.

Harberger, himself, notes general problems with international aspects of these models, specifically the stylistic nature of these models and the assumption (common to all the models) 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.¹¹”

¹¹ Harberger (2008, pp 301-302)

There are, in fact, several theoretical and practical concerns in relying on these models to allocate the current corporate tax. First, these models rely on stylized scenarios of a corporate tax system within a global economy and do not reflect the 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 any changes from 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 subsidy on debt relative to equity could result in capital inflow with an increase in the corporate tax. Such an inflow could occur because the higher tax rate would make debt financing favored by corporations, driving up interest rates. The higher return to debt provides 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 would 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) show the consequences of including debt in simulations of integration proposals. One integration approach they consider is to allow a credit to shareholders for corporate taxes paid in proportion to the corporate earnings paid out as dividends. To ensure revenue neutrality, a lump-sum tax or 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 would result. 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 higher increase in tax on interest. The greater international mobility of debt relative to equity and the tendency for foreign holdings to be

concentrated in debt allows for the net effect to be an inflow of capital. They also present a scenario that relies on a lump-sum tax that does not have the effect of introducing a higher tax on individual interest income, which also shows a net inflow, albeit smaller.

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 become much more like a closed economy, and the tendency of the allocation of corporate tax burden will be toward 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 provide estimates of the incidence 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. 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. However, if every country relied on the same analysis from the open economy models (for example, to assume that 40 percent of the burden falls on labor) then the per-country burden assumptions would not aggregate to 100 percent falling 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 nation. Assume both countries have a corporate tax. For this example, we use the burden allocation

¹² See also Randolph (2006) for a discussion on the implications of tax competition among countries.

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 is borne by foreign capital. This breakdown suggests that the burden allocation for the United States is 21/72 on labor and capital, but is -19/30 for foreign. If the foreign country made the same assumption of 21/72 on labor and capital, it would not be adjusting for the -19/30 effects from 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, it would not allocate the total tax, because the exported tax effects are not included. These issues suggest that it may not be appropriate to rely solely on the estimates of those models to allocate the entire corporate tax burden.

An Alternative Approach to Allocating Corporate 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 new view of the property tax (first originated by Mieszkowski, 1972) considers the impact of a local tax from the perspective of the entire country. Until Mieszkowski, 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, 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. Mieszkowski, in his development, 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,

¹³ For a review of the new view of property tax incidence, see also Zodrow (2000). For implications on using the new view for estimating incidence, see Jennifer Gravelle (2007).

100 percent of the effective national tax falls on capital, and there are also excise taxes and subsidies that vary across jurisdictions because of differentials from the average national tax rate.

There are some similarities between the treatment of jurisdictional tax differences for property taxes within a nation and worldwide jurisdictional corporate tax differences. Based on this similarity, it may be that analysis of corporate tax incidence would be aided by applying the new view's notion of differential tax rates, treating countries as states. Under this type of analysis, there would exist a worldwide average tax on capital, which, by virtue of being a worldwide tax, 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 the differential allocation. Estimates using a straight average of the OECD country tax rates and those relying on a GDP weighted average of OECD country tax rates are given, to demonstrate the effect of weighting the tax rates. A simple average allows very small countries, such as Ireland or Luxembourg, to have strong effect on the average rate, forcing it farther from representing a "worldwide" rate. 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 flowing overseas. The remaining differential profits tax would be allocated according to estimates from the open-economy models, in this case assumed to be 60 percent to capital and 40 percent to labor. In the United States example, 60 percent

of the remaining 15 percent of the U.S. tax would be allocated additionally to capital, yielding a 9 percent residual capital tax from the excise effect. Thus the tax burden borne by total U.S. capital would be 94 percent. Countries that have corporate tax subsidies show more than 100 percent of the burden falling on capital because the subsidy they provide does not fall entirely on capital, but also benefits labor. Effectively, high corporate-tax countries export a burden on capital and import a burden on labor.

Table 9: Burden Allocations of Corporate Taxes Across the OECD Countries, 2008

	Share of Corporate Tax Burden						
	Corporate Tax Rate ^a	Average OECD Corporate tax rate = 26.6%			GDP Weighted OECD corporate tax rate = 33.4%		
		Total Capital	Labor	Capital Through Residual ^b	Total Capital	Labor	Capital Through Residual ^b
Australia	30%	95%	5%	7%	105%	-5%	-7%
Austria	25%	103%	-3%	-4%	113%	-13%	-20%
Belgium	33.99%	91%	9%	13%	99%	1%	1%
Canada	33.50%	92%	8%	12%	100%	0%	0%
Czech Rep.	21%	111%	-11%	-16%	124%	-24%	-35%
Denmark	25%	103%	-3%	-4%	113%	-13%	-20%
Finland	26%	101%	-1%	-1%	111%	-11%	-17%
France	34.43%	91%	9%	14%	99%	1%	2%
Germany	30.18%	95%	5%	7%	104%	-4%	-6%
Greece	25%	103%	-3%	-4%	113%	-13%	-20%
Hungary	20%	113%	-13%	-20%	127%	-27%	-40%
Iceland	15%	131%	-31%	-46%	149%	-49%	-74%
Ireland	12.50%	145%	-45%	-68%	167%	-67%	-100%
Italy	27.50%	99%	1%	2%	109%	-9%	-13%
Japan	39.54%	87%	13%	20%	94%	6%	9%
Korea	27.50%	99%	1%	2%	109%	-9%	-13%
Luxembourg	30.38%	95%	5%	7%	104%	-4%	-6%
Mexico	28%	98%	2%	3%	108%	-8%	-12%
Netherlands	25.50%	102%	-2%	-3%	112%	-12%	-19%
New Zealand	30%	95%	5%	7%	105%	-5%	-7%
Norway	28%	98%	2%	3%	108%	-8%	-12%
Poland	19%	116%	-16%	-24%	130%	-30%	-45%
Portugal	26.50%	100%	0%	0%	110%	-10%	-16%
Slovak Rep.	19%	116%	-16%	-24%	130%	-30%	-45%
Spain	30%	95%	5%	7%	105%	-5%	-7%
Sweden	28%	98%	2%	3%	108%	-8%	-12%
Switzerland	21.17%	110%	-10%	-15%	123%	-23%	-35%
Turkey	20%	113%	-13%	-20%	127%	-27%	-40%
U.K.	28%	98%	2%	3%	108%	-8%	-12%
U.S.A.	39.25%	87%	13%	19%	94%	6%	9%

^a Top statutory rates, federal plus provincial/state, 2008

^b 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.

Source: Analysis of data from OECD Annual National Accounts.

Conclusion

This review suggests that the assumption of an open economy is not sufficient to conclude that much of the burden of the corporate tax is shifted to labor. Indeed, assumptions of highly mobile capital and highly substitutable products, internationally, are needed to ensure that the majority of the tax is borne by labor. Relaxing the assumptions of perfect mobility changes the burden allocation to indicate that, even in an open economy, a majority of the corporate tax burden, perhaps 60 percent, is still borne by capital.

In addition, concerns arise over the reliance on these empirically-based general equilibrium models, extensively developed as they are, because they 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 the imperfect international mobility assumptions, suggesting capital would bear the bulk of the corporate tax.

The nature of these models is 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 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 capital.

Even when using the standard open-economy models, it is clear that minor additions of rigidity through immobile capital or imperfect product substitution can result in capital bearing a major portion of the tax. The open economy assumption should not be synonymous with the conclusion that labor bears more of the burden of the corporate tax than capital does.

Appendix. Closed-Economy Models of Corporate Tax Incidence

The following section reviews the standard Harberger model and highlights some of the main adjustments made to that model. The first section provides a summary of the original general equilibrium model formulated by Arnold Harberger and reports some of the main implications for the incidence of the corporate tax. The second section provides a brief review of the main adjustments with a closed economy to the structure of Harberger's original model.

Harberger Model

A primary contribution of Harberger's model to the early analysis of corporate tax incidence was the finding that the burden of the tax is shared between capital and labor income and is not shifted forward to consumers, because such a shift would allocate the tax proportionally to labor and capital based on the original factors' shares of income. Harberger first outlines a series of general results and then, relying on assumed factor and product substitution elasticities, derives estimates of the share of burden borne by capital and labor. He finds that:

- Labor can bear more in proportion to its initial share of income only if the taxed industry is labor-intensive.
- Capital will bear more of the tax burden than labor (relative to initial shares) if the factor substitution elasticity in the taxed sector is greater than the product substitution elasticity between the taxed and untaxed sectors.
- The higher the 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 numerical estimates, Harberger concluded that most of the burden of the tax falls on capital income. He assumed factor substitution elasticities of 0.5, 0.66, 0.8, 1, and 1.2 and product

substitution elasticities of 0.5, 1, and 1.5. When the factor substitution elasticities and the product substitution elasticities all equal 1, capital will bear 100 percent of the burden. This result is not an extreme case; it is a central tendency of Harberger's numerical estimates based on the underlying assumptions in the model. He found that, when the factor substitution elasticity is lower in the untaxed sector than in the taxed sector, capital can bear more than 100 percent of the tax; conversely, when the factor substitution elasticity is higher in the untaxed sector than in the taxed sector, capital bears less than 100 percent of the burden. In addition, if the product substitution elasticity is lower (higher) than one, capital bears more (less) than 100 percent of the burden.

Two general effects explain these results: a substitution effect and an output effect. The substitution effect is triggered by the cost of capital rising, as a result of the tax. The taxed sector has an incentive to substitute labor for capital. The excess capital is absorbed in the nontaxed sector but at a lower rental–wage ratio. The extent of this effect is determined by the relative substitution elasticities in the two sectors. When capital and labor are less substitutable in the untaxed sector, capital can bear more than 100 percent of the burden because, for the untaxed sector to absorb the excess capital from the taxed sector, it must also increase the amount of labor, further decreasing the demand for capital relative to labor. When capital and labor are less substitutable in the taxed sector, capital still can bear more than its proportion because it is less mobile. The untaxed sector, however, can easily substitute capital for labor. The higher substitution in the untaxed sector leads to an increase in the demand for capital relative to labor, reducing wages paid to labor. The substitution effect, overall, generally reduces the return on capital relative to wages (r/w).

The tax also decreases the demand for the output of the taxed sector relative to the untaxed sector. The extent of this output effect depends on the product substitution elasticity and relative capital intensities. The reduced demand flows through to a reduction in the demand for both factor inputs. The excess demand or supply of capital relative to labor depends on the relative factor intensities in the two sectors. If the taxed sector is capital-intensive, the lowered demand for the taxed output translates to less

demand for capital relative to labor, further decreasing the rental–wage ratio—reinforcing the substitution effect—and resulting in capital bearing more of the burden of the tax. If the taxed sector is labor-intensive, then the lowered demand for labor increases the rental–wage ratio—counteracting the substitution effect and resulting in capital bearing less of the burden of the tax.

Variations on the Harberger Model

Following Harberger’s development of the general equilibrium model approach to analyzing corporate tax incidence, there were many studies that made numerous adjustments to test the robustness of his conclusions.¹⁴ Although the results of these studies (discussed below) did reveal scenarios where the results could differ from Harberger’s conclusions, none of the studies ruled out the ability, under largely reasonable assumptions, for capital to bear 100 percent of the burden. In general, economists concluded that Harberger’s model was sound and agreed that capital bore most, if not all, of the burden of the corporate tax.

Shoven (1976) adjusted Harberger’s standard model to incorporate many more subsectors within the corporate and noncorporate sectors. He included three noncorporate sectors (agriculture, real estate, and oil and gas) and nine corporate sectors. His initial results were in line with Harberger’s results using the same values of factor substitution. As Harberger suggested, the incidence on capital would be sensitive to the factor substitution elasticity in the untaxed sector. Shoven finds that the burden on capital increases using a factor substitution elasticity of 0.25 in the untaxed sector. Shoven’s results also showed

¹⁴ This review does not address adjustments that remove the fixed capital stock and allow for savings responses, as in Ballentine (1978), who found that allowing for a nonfixed capital stock could have significant effects on the incidence of the corporate tax. This adjustment goes beyond the scope of this paper, because allowing for savings responses is not specific to the corporate tax but concerns taxes on capital in general. Furthermore, analysis of the incidence on capital is difficult to define when the size of the factor is changing. Last, as Auerbach and Kotlikoff (1987) discuss, the results from savings responses are indeterminate. In addition, adjustments for labor supply or unemployment, as made in studies by Zee (1983) and Miyagiwa (1988), suffer from similar difficulty of determining incidence on factors whose size is changing, and thus are not discussed in detail in this paper.

that the incidence of corporate tax is more sensitive to the factor substitution elasticity in the taxed sector than that in the untaxed sector.

Batra (1975), Ratti and Shome (1977a, 1977c), and Baron and Forsythe (1981) all make adjustments to the Harberger model to allow for uncertainty. Batra adjusts Harberger's model for uncertainty by adding a random component to corporate production. The random component could represent fines, plant breakdowns, morale, or other factors that could randomly or unpredictably affect output. Those factors, however, do not apply to the noncorporate sector in his model. Batra does not make empirical estimates because of severe data constraints on estimating expected utility. He finds, however, that, under reasonable conditions of risk aversion, capital will still bear a greater burden in proportion to its income share than labor, provided the corporate sector is the capital-intensive sector.¹⁵ He also concludes that, although not assured, it may be asserted that capital is likely to bear a greater burden of the tax than labor, regardless of capital intensity. He also finds that, if relative risk aversion is nondecreasing in profits, incidence is indeterminate.

Ratti and Shome (1977c) allow for uncertainty in one sector, using a method similar to that employed by Batra. They look at the incidence effects of a variety of taxes: partial factor tax, general factor tax, general income tax and general sales tax, distinguishing between a general tax on capital and a tax applied specifically to corporate income. The factor tax will be borne entirely by the taxed factor when certainty is assumed. Ratti and Shome find the same result holds under uncertainty with constant absolute risk aversion. They find that a general income tax is borne by both factors in proportion to their initial income shares and will continue to hold under uncertainty if there is constant absolute risk aversion. They do not consider a partial income tax on the corporate sector.

A subsequent paper by Ratti and Shome (1977a) corrects and extends Batra's work. They find that his conclusion is correct with adjustment. Assuming nonincreasing absolute and relative risk

¹⁵ Such reasonable conditions of risk aversion might include nonincreasing absolute and relative risk aversions, conditions often employed in uncertainty analysis.

aversion, capital will still bear a greater burden in proportion to its income share than labor, provided the corporate sector is the capital-intensive sector. They also find that, if uncertainty is located in the noncorporate sector, then if the corporate sector is capital-intensive relative to the noncorporate sector, capital must bear a greater burden of the tax in proportion to its share of income than labor only if the absolute risk aversion of the noncorporate firms is a nonincreasing function of profit.

Baron and Forsythe also add uncertainty, but assume that securities of the firm are traded and that production is subject to uncertainty at multiple levels. By assuming that firms are not owned by a single individual but by many through corporate securities trading, they find that Harberger's results also hold under uncertainty without the additional risk-aversion requirements included in Batra, and Ratti and Shome.

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. They find that adding land changes some of Harberger's general conclusions. Most notably, labor intensity in the taxed sector is no longer necessary for labor to bear the burden of the tax. They find, assuming a factor substitution elasticity of 1.6 to 2.4 for the agricultural sector, that capital does not bear 100 percent of the tax, that land benefits from the tax, and, that the burden is shared with labor.

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. If there are differences between the wages in the two sectors, and if the demand elasticity is large relative to factor substitution elasticities, the return to capital can increase relative to wages. This result arises because the output effect is larger than the willingness to substitute capital for labor. In an environment with significant labor immobility, labor can bear more of the burden than capital.

Bhatia (1981) introduces intermediate goods to the analysis. Similar to Ratti and Shome's introduction of land, the addition of intermediate goods greatly expands the available factors for

substitution: capital and labor for final taxed goods, final untaxed goods, and intermediate untaxed goods. Although several of Harberger's general results hold with the addition of intermediate goods, Bhatia notes that other findings are no longer applicable. Specifically, in the Harberger model, if factor substitution elasticity in the taxed sector is greater than or equal to the demand elasticity for the taxed good, capital will bear the tax more than proportionally. This result no longer can be assured with the introduction of intermediate goods. With all elasticities unitary, however, Bhatia's results are the same as Harberger's.

Parai (1988) uses Harberger's model and incorporates variable returns to scale. He finds that if returns to scale are non-increasing, then Harberger's results hold and capital can bear more of the burden. Even if the output effect reinforces the substitution effect, which suggests capital bears more of the burden, increasing returns to scale can keep the value and demand for capital up, reducing the share of the corporate tax burden borne by capital.

Gravelle and Kotlikoff (1989) make a point that Harberger's model has a fundamental flaw by assuming that production and corporate status are one and the same. They provide a variation on his model, allowing for both corporate and noncorporate production of the same product. They note that others have done a variation only to find that the corporate sector disappears under a corporate tax. To ensure that the corporate sector continues to be viable (as is clearly seen in the United States), they allow for entrepreneurial aspects in noncorporate sector and size requirements in the corporate sector. Like Harberger's results, they find that if all elasticities are equal, the burden of the tax falls completely on capital. Unlike Harberger, however, they find that capital can still bear 100 percent of the burden regardless of the elasticity of substitution. They find that higher demand elasticity raises capital's share of the burden, but Harberger found it lowered the burden share.

Parai and Choudhary (1992) allow for imperfect labor mobility. They find that although labor immobility clearly makes it more possible that labor will bear a larger burden than capital, perfect labor

mobility “is not necessary for the validity of Harberger’s basic result.”¹⁶ If the elasticity of labor mobility is not too small, capital may still bear more burden than labor. Labor immobility does, however, reduce the effects of the corporate tax on rental rate. If labor is not perfectly mobile, the ability to substitute capital for labor when capital becomes expensive is lessened. Labor immobility also increases the power of the output effect on the wage rate, driving down wages and increasing the burden on labor.

¹⁶ Parai and Choudhary (1992), p. 79.

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