Passing the Burden: Corporate Tax Incidence in Open Economies[1]

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October 2007

Abstract

High rates of corporate taxation reduce corporate investment and thereby depress local wages. Using cross-country data I estimate that a ten percentage point increase in the corporate tax rate of high-income countries reduces mean annual gross wages by seven percent. The results do not support the common belief that the burden of corporate taxes falls most heavily on skilled labor; corporate taxation appears to reduce the wages of low-skill and high-skill workers to the same degree. The incidence of the corporate tax in the form of reduced wages suggests that taxing labor instead of taxing corporations could be Pareto-improving.

Keywords: Tax incidence, Corporate taxation, Tax progressivity

[1] The author would like to thank James R. Hines Jr., Joel Slemrod, Dan Silverman, Clemens Sialm and participants at University of Michigan's Public Finance Seminar for invaluable comments and suggestions. All remaining errors are, of course, my own.

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1. Introduction

Corporate taxation has long been used in an attempt to increase the progressivity of the tax structure and redistribute income, but as the economy becomes more open, the burden of these taxes shifts from capital to labor, reducing their progressivity. Thus, taxing corporations may create inefficiencies that do not produce the desired redistributive benefits. Reassessing the incidence of corporate taxation in an open economy setting is necessary to aid policymakers' decisions in designing tax policy that produces the desired revenue and redistributive properties with the smallest possible deadweight loss.

It is well-known that those responsible for remitting taxes are not always those who bear the burden of the tax. Early economic literature focuses on the incidence of taxes in a closed economy, and Harberger (1962) estimates that capital, both corporate and non-corporate, bears the entire burden of the corporate tax in a closed economy. He shows that this creates an inefficient allocation of capital between the corporate and non-corporate sectors. Most corporate capital is owned by the wealthy but some non-corporate capital is owned by the middle class, and thus, corporate taxation was initially seen as a way to increase the progressivity of the tax system even though the tax was slightly less progressive than originally believed.[1]

As trade barriers were removed over time, volumes of trade and capital flows rose, requiring a new look at the incidence of taxes-- one that focuses on the impact of openness. Diamond and Mirrlees (1971) demonstrate that in a small open economy, any source-based capital tax is inefficient. Their theory predicts that as the economy becomes open, capital becomes more mobile, and thus the price of capital is fixed at the world return. Therefore, if a country places a tax on capital, capital will flee to obtain the higher after-tax world rate of return. Capital will continue to move abroad until the marginal productivity of capital at home is driven

up to the point where the after-tax return to capital equals the world return. This decrease in capital results in a lower marginal productivity of labor and thereby, if capital is perfectly mobile, labor bears the entire burden of a capital tax. Harberger (1995) also revisits the incidence of corporate taxation in an open economy finding that the burden of a corporate tax more than fully shifts to labor. He estimates that the burden on labor may be 2 to 2.5 times as large as the corporate tax revenue raised. As Harberger points out, the openness of a country remains a crucial factor in analyzing the incidence of a corporate tax.

Randolph (2006) and Gravelle and Smetters (2006) both develop general equilibrium models in an open economy to examine the incidence of the corporate tax. Randolph finds that labor bears 70 percent of the corporate tax in a model in which worldwide capital stock is fixed. Gravelle and Smetters similarly assume the capital stock to be fixed and focus on product substitutability. They find that labor bears less than 70 percent of the corporate tax if products are not perfectly substitutable. Low savings elasticity and the ability of a country to affect world prices also reduce labor's burden in their model. However, by ignoring the effect of corporate taxes on the growth of capital, these models likely underestimate the impact of corporate taxes on labor.

While literature in this area has focused heavily on the theoretical side of the issue, this paper uses an empirical approach to measure the first-order effect of openness on the incidence of corporate taxation by looking at the effect of openness, corporate taxes and their interaction on the gross wages of workers. Using cross-country panel data from the Luxembourg Income Study, I estimate that a ten percentage point increase in the corporate tax rate decreases annual gross wages by seven percent. Using U.S. data on corporate tax revenues and total wages, these estimates predict that labor's burden is more than four times the magnitude of the corporate tax

revenue collected in the U.S. While this estimate is nearly twice as large as Harberger's (1995), his estimate that labor bears 2 to 2.5 times the corporate tax revenue cannot be rejected in my estimates. In addition, Harberger estimates the burden of the corporate tax on labor but does not include an estimate of the deadweight loss associated with the corporate tax.

Openness, as measured by total trade divided by GDP, also has a negative effect on wages; a ten percentage point increase in openness is estimated to decrease annual gross wages by four percent. The interaction of corporate tax rates with openness has a positive effect on wages in the data. This is consistent with a model in which corporations are better able to avoid taxes in more open economies. I examine this theory by comparing the effects of marginal and average corporate tax rates on wages. In my data, the difference between marginal and average corporate tax rates is positively correlated with openness suggesting that corporations are better able to lower their average tax rate in more open economies. Further examination of this theory would be an interesting addition to the tax avoidance literature.

To analyze completely the progressivity of corporate taxes, one must look at the effect of corporate taxes across workers of differential skill. There are theoretical reasons to believe that the effects of corporate taxation will vary across skill-level. Griliches (1969) finds that capital and unskilled labor are more substitutable than capital and skilled labor, creating the capital-skill complementarity hypothesis. The capital-skill complementarity hypothesis predicts that the elasticity of substitution between capital and skilled labor is lower than the elasticity of substitution between capital and unskilled labor. Bergstrom and Panas (1992) show the robustness of this result in an empirical analysis using Swedish manufacturing data. The capital-skill complementarity hypothesis suggests that the decrease in capital due to an imposition of corporate taxes should have a larger effect on skilled labor, as opposed to unskilled labor. Thus,

in an open economy, we should expect wages of skilled labor to decrease by more than the wages of unskilled labor as a result of higher corporate tax rates. Although wages of all types of labor will be depressed by a corporate tax, theory suggests that the burden of corporate taxes is borne more heavily by skilled labor especially as the economy becomes more open.

Past research provides the foundation to analyze the effects of corporate taxes and openness on wages across skill-level. I find little evidence, however, that corporate taxes have a larger negative effect on wages of skilled labor. In fact, results suggest that corporate taxes have similar effects on annual gross wages for all skill groups. Differences in international labor mobility may provide one explanation of these results. If high-skill labor is more internationally mobile, then they can pass some of the burden of the corporate tax on to less mobile factors. These results combined with the sizable inefficiencies created by corporate taxation suggest that taxing labor directly may result in a Pareto-improving outcome with the same tax progressivity of the current tax system.

A recent empirical contribution, Hassett and Mathur (2006), also finds that labor more than fully bears the burden of corporate taxes in an open economy; they estimate that a one percent increase in the corporate tax rate results in a 0.8 to 1.0 percent decrease in the manufacturing wage rate. Using U.S. data, their results translate into a burden on labor that is approximately five times the magnitude that I find.

The central motivation of this paper is to estimate the incidence of the corporate tax in an open economy. In addition, I analyze these impacts across skill-level and find that openness may lead to more active tax avoidance. A closer examination of the economic theory behind the incidence of corporate taxes in an open economy follows in Section 2. The data used in the

empirical analysis are described in Section 3. Empirical results are analyzed in Section 4; conclusion and policy analysis follow in Section 5.

2. Theory

2.1 The Effect of Corporate Taxes on Wage

In a closed economy, Harberger (1962) finds that corporate taxes do not affect wages. In Harberger's model, the economy is closed, the quantities of capital and labor are fixed, and capital and labor are freely mobile between industries. In this setting, if a source-based corporate tax is imposed, the after-tax return to capital in the corporate sector will decrease. Capital will move to the non-corporate sector in pursuit of higher returns until the after-tax returns have equalized across the corporate and non-corporate sectors. This increase in capital in the non-corporate sector will decrease the marginal productivity of capital in that sector resulting in a lower return. Similarly, as capital leaves the corporate sector the marginal productivity of capital in that sector will rise. Labor can move between sectors to ensure that their wages will not change due to changes in the amount of capital. Thus, the burden of the corporate tax falls entirely on capital in both the corporate and non-corporate sectors.

There are several lessons to take away from Harberger's model. First, the mobility of factors within a country ensures that the return to a factor must be equal across sectors. Also, with a fixed supply of capital and a closed economy, labor bears none of the burden of a source-based corporate tax. In this model, deadweight loss is created by the inefficient allocation of capital between corporate and non-corporate industries. Harberger estimates a deadweight loss of only eight percent of corporate revenue. Gravelle and Kotlikoff (1993) add product differentiation to the closed economy model and find that capital still bears the complete burden

of the tax. They estimate, however, that the deadweight loss created by corporate taxes is more than 100 percent of corporate tax revenue.

2.2 The Effect of Openness on Wages

Labor and international trade economists have devoted much energy and research to understanding the effect of economic openness on wages. Using the fundamentals they have developed will allow me to integrate the effect of openness on wages with the incidence of corporate taxation. The Hecksher-Ohlin model predicts that countries will tend to export goods and services whose production uses relatively intensely their comparatively abundant factor. Most developed countries have a relatively large endowment of capital compared to the rest of the world; therefore, the comparative advantage of most developed countries lies in capital intensive goods and services.[2] Thus, as the economy opens, these countries will shift production toward capital intensive industries. Factor price equalization predicts under strong assumptions that wages and the return to capital will equalize across countries over time with free trade. This result requires countries to possess identical technology and assumes that capital and labor are mobile within country but immobile between countries.[3] In addition, capital to labor ratios must be sufficiently similar across countries so that all countries will produce tradable goods employing both factors (i.e., production occurs in the cone of diversification). If factor price equalization or the weaker condition of factor price convergence holds, wages will fall in developed countries as more emphasis is put on capital-intensive industries. In my model, capital is internationally mobile; this assumption guarantees that every country will be in the cone of diversification if there are no impediments to trade, and thus, factor price equalization will hold.

2.3 The Effect of Openness on the Incidence of Corporate Taxes

In today's global economy, not only are goods and services traded among countries, but capital is also mobile. Capital mobility assures that the return to capital will be equal across countries. Therefore, if a tax on capital is levied in a single small country, it can not affect the worldwide return to capital. This can be seen in equation (1) where r^* is defined as the world rate of return on capital.

$$(1-\tau_K)MPK = r^* \tag{1}$$

If the tax on capital (τ_k) is increased, the marginal productivity of capital (*MPK*) must increase in order to keep the return to capital set at the world price. This occurs as capital flees the home country in pursuit of a higher return; the decrease in capital will increase the marginal productivity of capital in the home country and investors will continue to pursue outside opportunities until the marginal productivity of capital has increased to the point where equation (1) holds. As producers in the home country use less capital, the marginal productivity of labor will decline resulting in lower wages at home. Thus, a tax on capital is borne entirely by labor in a small open economy, and we would expect the corporate tax rate to have a negative effect on wages.[4]

Harberger (1995) reevaluates the incidence of the corporate tax by assessing the burden of the tax in an open economy. Not only does Harberger find a negative effect of corporate taxes on wages, but he also finds that labor's burden from corporate taxation is 2 to 2.5 times as large as corporate tax revenue. In an open economy, there are more opportunities for inefficiencies to occur as a result of source-based corporate taxes. As in the closed economy, capital may be inefficiently allocated between the corporate and non-corporate sector within a country; in addition, capital may now be inefficiently allocated across countries. In an open economy,

corporations may alter their business decisions in order to minimize their tax burden causing further inefficiencies within individual corporations.

2.4 Tax Incidence across Skill-Level

If the burden of a corporate tax is expected to fall on labor, it is important to understand the differential impact across skill. The principal mechanism by which labor bears the burden of the corporate tax is via decreased marginal productivity of labor due to capital flight. By determining how decreased capital differentially impacts labor productivity across skill, we can understand its effect on wages. The elasticity of substitution between capital and labor plays a key role in determining the impact of decreasing capital on wages. If the elasticity of substitution between capital and labor and labor's share of output is constant across skill, then any change in capital should not differentially impact wages across skill.

Griliches (1969) estimates that capital is more complementary with skilled labor relative to unskilled labor. This finding is known as the capital-skill complementarity hypothesis. Bergstrom and Panas (1992) use 12 different models to show that this hypothesis holds in 92 percent of cases. If capital and skill are relatively more complementary, we should expect that any change in capital will have the largest impact on skilled labor. In a small open economy, theory tells us that the burden of a capital tax falls on labor because corporate taxation leads to a decrease in capital in the home country. Combining this theory with the capital-skill complementarity hypothesis, the burden of a corporate tax should be heaviest on high-skill labor since lower levels of capital will have the largest negative effect on this group.

This result can also be seen in a model. To choose the appropriate production function, I refer to a large body of economic literature estimating the elasticity of substitution between

various types of labor and capital. In order to allow for different elasticities of substitution between types of labor and capital, I use a nested CES production function. I follow the direction of Fallon and Layard (1975) who find that equation (2) is the most accurate specification for a two-level nested CES production function where L_1 is skilled-labor and L_2 is unskilled labor. The production function in equation (2) assumes that the elasticity of substitution between capital (K) and unskilled labor (L_2) is equal to the elasticity of substitution between skilled (L_1) and unskilled labor. This elasticity of substitution is defined as 1/ (1-ρ). The elasticity of substitution between skilled labor and capital is defined as 1/ (1- θ). If ρ > θ, then skilled labor is more complementary with capital than unskilled labor.

$$Q = A\left[a\left\{ bK^{\theta} + (1-b)L_1^{\theta} \right\}^{\rho/\theta} + (1-a)L_2^{\rho} \right]^{1/\rho}, \qquad \theta, \rho \leq 1 \tag{2}$$

In order to coincide with my data, I augment this production function in order to allow three types of labor: high-skill, medium-skill, and low-skill, as seen in equation (3). I assume that L_1 is high-skill labor, L_2 is middle-skill labor and L_3 is low-skill labor because past literature suggests that this specification most accurately describes the data. However, this assumption is not needed for the results to hold. High-skill labor is the most complementary with capital, followed by middle-skill if β > γ > θ. However, this production function does not assume that L_1 is most complementary with capital; this is determined by the values of β, γ, and θ. The function does assume that the elasticity of substitution between K and L_2 is equal to the elasticity of substitution between L_1 and L_2.

$$Q = \left\{ c\left[b\left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{\beta}{\gamma}} + (1-c)L_3^{\beta} \right\}^{\frac{1}{\beta}} \tag{3}$$

If all types of labor have the same elasticity of substitution with capital (i.e. $\beta = \gamma = \theta$) and the supply of all types of labor is fixed, then the burden of the corporate tax across skill-level will be constant. If, however, the capital-skill complementarity hypothesis is correct and $\beta > \gamma > \theta$, then the ratio of high-skill wages to middle-skill wages increases with capital and the ratio of middle-skill wages to low-skill wages increases with capital. These results are derived in Appendix A.

3. Empirical Set-Up and Data

In order to test empirically the impact of openness on the incidence of corporate taxation, we must first determine the variables that affect the gross wage of an individual. In a simple model, we expect that both individual characteristics (*I*) and country characteristics (*C*) impact individual wages. In the specification below, gross wage represents the mean annual gross wage of individuals of skill-level (*s*) in a given country (*j*) and year (*t*).

$$\ln(gross\ wage_{jts}) = \alpha + \beta I_{jts} + \gamma C_{jt} + \varepsilon_{jts} \quad (4)$$

Education level is the primary individual characteristic of interest. Mincer (1984) develops the standard human capital earnings function; he formulates that an individual's wage is a function of years of schooling, experience, and experience squared. This formulation has been empirically tested many times resulting in positive coefficients on years of schooling and experience and a negative coefficient on experience squared.[5] Gender is also likely to affect wages and is often included as an independent variable. However, gender is often combined with labor supply considerations because women's labor supply often varies over time.[6]

The country characteristics of interest include the corporate tax rate, openness and the interaction of the corporate tax rate with openness. I also include GDP per capita to control for

country-level omitted variables that may be correlated with the residual. All of my estimations include random effects and cluster the standard errors at the country level. Using random effects allows me to look at the effects between countries in addition to over time. Several countries in my data include only one year of data making fixed effects an unattractive alternative to random effects.

3.1 Luxembourg Income Study

The Luxembourg Income Study (LIS) is a panel database covering 30 countries over 5 waves of data from 1979 – 2002.[7] The LIS compiles data from country specific household income surveys. For example, individual data for the United States is taken from the Current Population Survey. The dataset includes individual and household data on demographics, expenditure, income, labor market outcomes and tax variables. This dataset is a rich source of data that has been underutilized in economic literature.

The LIS database does, however, have some limitations. Not all of the variables are available in all of the countries and years. Second, and more problematic, many variables are not defined consistently across countries. For example, the United States' education variable records years of education, while Canada's education variable records levels (i.e., graduated high school, university degree …) of education. The LIS does provide a recoding of the education variable for many countries that helps circumvent this problem. Third, income variables are generally available as net or gross income but not both.

The LIS education recode program groups each individual's education into one of three categories: low, middle or high. High education includes those with a college degree and above. Middle education includes those with a high school degree but not a college degree. Low

education ranges from no education to some education not including a high school degree. The education recoding uses the 1997 International Standard Classification of Education from the United Nations Educational, Scientific and Cultural Organization; the LIS believes this recode to produce an education variable that is as comparable across countries as possible. For this paper, I only include countries for which a reclassification is available; some countries were not able to be recoded.[8]

In the LIS data, each country/year observation is a separate dataset; thus, to avoid possible inconsistencies between countries I do not merge the datasets. Therefore, for each country/year observation, I sort individuals by education level; each observation in my dataset is a specific country, year and education level. Any individual characteristics, therefore, are the mean value of that characteristic across education level within a given country and year.

For each observation, I am interested in the mean annual gross wage of individuals within skill.[9] Unfortunately, gross income is only available for approximately half of the countries; the remaining countries have income provided as net. In order to maintain a sample size large enough for statistical inference, I transform the average net income by education level into average gross income by education level using each country's tax code for the specified year.[10] I obtain countries' tax codes from Individual Taxes: A Worldwide Summary. My calculation takes into account national income tax, local income tax, and the employees' contribution to social security. Table 1 lists the countries and years included in my data and indicates those countries for which net income has been transformed into gross income.[11] Figure 1 shows the average gross wage by education level for France, Denmark and Greece. As expected, higher levels of education always result in a higher wage. Gross wages by education, marginal corporate tax rates and openness measures for all countries in 1994/1995 are displayed in Figure 2.

3.2 Measures of Openness

Openness is a variable that can be approximated in several ways, and in the current literature, several approximations are used. Therefore, I will look at three different measures of openness. The first is the ratio of total trade (exports plus imports) to gross domestic product and is obtained from the World Bank's World Development Indicators. The second measure I consider is the Chinn-Ito Financial Openness Index. The Chinn-Ito Index measures capital account openness and provides data for 163 countries from 1970 to 2004. The Chinn-Ito Index is calculated using restrictions on cross-border financial transactions that are available from the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions. The third measure used is the Economic Globalisation Index provided by the Centre for the Study of Globalisation and Regionalisation at the University of Warwick. This index is calculated using data on trade, foreign direct investment, portfolio investment and income from foreign workers, foreign assets, expatriates and foreign-owned domestic assets. The primary estimates in this paper will include openness as measured by total trade divided by GDP. However, tables providing estimates using the other two measures of openness are available in Appendix B.

3.3 Corporate Tax Rates and Country-level Data

The key variable of interest in this paper is the corporate tax rate. Each country's highest marginal corporate tax rate is available from the World Tax Database provided by the Office of Tax Policy Research at the University of Michigan. For most countries, corporate tax rates tended to fall from 1979 to 2000. Switzerland has the lowest corporate tax rate at 9.8 percent in

1992; Germany has the highest marginal corporate tax rate at 56 percent in 1984 and 1989. The mean, marginal corporate tax rate in my dataset is 36 percent. For comparison, I also use the average corporate tax rate in some estimations. These data are obtained from the Statistics of Income Bulletin and are calculated by dividing the taxable foreign earned income by the foreign taxes paid by U.S. multinational firms in a foreign country. The average corporate tax rate may be a more reliable measure of cross-country differences in tax rates because it accounts for differences in taxable income, credits and depreciation allowances.

Additional data obtained from the LIS include gender and age; each variable is entered as the average value by education level. Age is included in my regressions as a proxy for experience. The number of years of education is not available for most individuals, and thus, a more precise measure of experience is not possible. GDP per capita, value added in industry per worker and the consumer price index are obtained from the World Development Indicators. All monetary values are represented in real U.S. dollars (2000 base year). These values have been calculated using exchange rates and the GDP deflator available from the World Development Indictors. Summary statistics are provided in Table 2.

4. Results

4.1 Corporate Taxes and Openness

Openness and the corporate tax rate are the two main country characteristics of interest for this paper. In Section 2 we established that the corporate tax rate should have a negative impact on the gross wage of workers. The effect of openness is harder to predict ex-ante; the countries in the dataset are developed countries that are relatively capital-intensive. Thus, as the economy opens, wages for labor should fall. Table 3 shows the estimated effect of corporate

taxes and openness on annual gross wage. All regressions in this paper include random effects, and the standard errors are clustered at the country level. Dummy variables for low and middle education levels are included to measure the return to education. The year is entered as a linear trend; this assumption is made because entering the years as dummy variables would cost many degrees of freedom in an already small sample. In addition, there are several countries for which I have only one year of available data. Table 3 estimates that a one percentage point increase in the corporate tax rate results in a 0.5 – 0.7 percent decrease in gross annual wages. In these specifications, however, the coefficient on corporate taxes is not statistically significant. Openness, as measured by total trade divided by GDP, also has a negative impact on wages; a one percentage point increase in openness results in a 0.23 – 0.48 percent decrease in gross wages. Openness is statistically significant in both specifications for which it is included.

As expected, there are positive returns to education; the estimates predict that an individual with a low level of education will earn approximately 70 percent less than an individual with a high level of education. Individuals with a middle education are estimated to earn approximately 30 percent less than those with a high level of education. These findings are statistically significant and remain consistent throughout the results. The individual characteristics of age, age-squared and male are not statistically significant. This is not surprising since these variables are measuring the mean value within an education group, and there is little variation in these measures across skill level. In column III, a ten percentage point increase in the marginal personal income tax rate is predicted to increase annual gross wages by 7.4 percent. This positive coefficient may indicate that labor does not bear the full burden of the personal income tax. However, this result should be interpreted with caution as the marginal personal tax rate is used to transform net wages into gross wages for approximately half of the observations.

Hassett and Mathur (2006) have recently estimated the effect of corporate taxes on gross wage rates in manufacturing industries. They find that a one percent increase in the corporate tax rate results in a 0.84 to 1.19 percent decrease in wage rates. As a robustness check of my results, I use my data to run the specifications used in Hassett and Mathur (2006). These results are presented in Table 4. Looking at column II, a one percent increase in the corporate tax rate is shown to decrease hourly wage rates by 0.43 percent.[12] The 95 percent confidence interval of this result falls entirely below the findings of Hassett and Mathur. In addition, my sample includes only OECD countries in which Hassett and Mathur find wages to be more correlated with corporate tax rates. My estimate of 0.43, therefore, should represent the upper-bound of their specification. This specification includes value added per worker in manufacturing. In a perfectly competitive model, we expect the marginal value added per worker to be equal to the wage rate. So, as expected, the correlation between wage rates and value added per worker is high. The predicted impact of the corporate tax rate on wages comes via a decrease in the marginal productivity of labor; thus, including value added per worker as an explanatory variable seems to give a coefficient on the corporate tax rate that is difficult to interpret.

4.2 The Interaction of Tax and Openness

As shown in Section 2, theory predicts that openness should have a large, negative impact on labor's burden from corporate taxation. Table 5 displays the empirical estimates with the added interaction between openness and the corporate tax rate.[13] Including this interaction term generates several interesting results.[14] First, the effect of the corporate tax rate on annual gross wages is similar to the results found in Table 3. However, the coefficients are now larger in

magnitude, statistically significant and predict that a one percentage point increase in the corporate tax rate will result in a 0.7 – 1.2 percent decrease in annual gross wages.

GDP per capita is included in column I in order to control for country level omitted variables that may impact gross wages. When GDP per capita is excluded from the specification as in column III the majority of the explanatory power of the regression is gone. In addition, the absolute value of the coefficient on the marginal corporate tax rate is larger when GDP per capita is not included in the regression. Thus, there must be a negative correlation between the marginal corporate tax rate and GDP per capita.

Perhaps the most interesting result is the significant, positive coefficient on the interaction of openness and corporate tax rates. Theory predicts that this coefficient should be negative. There are several explanations, however, that may explain the positive coefficient. First, all of the countries in my data are considered to be open economies by the Sachs-Warner openness index in the years used.[15] It is likely that having an open economy shifts the burden of the corporate tax from capital to labor but the degree to which a country is open does not have an impact. This would result in a coefficient close to zero. So why could the coefficient on the interaction term be positive? It may be that as an economy becomes more open, corporations are better able to avoid taxes. There is a large literature discussing the degree to which corporations actively avoid taxes by transfer pricing, debt/equity reallocation, and placement of branches.[16] Thus, it seems plausible that an increase in openness could result in an increase in the availability of practices that aid tax avoidance.

If it is true that as the economy becomes more open, corporations are more likely to avoid corporate taxes, then we would expect the average corporate tax rate to account for this avoidance. The average corporate tax rate is calculated by dividing the total foreign earned

taxable income by the foreign corporate taxes paid by U.S. multinational corporations as reported to the IRS. Thus, the average tax rate includes deductions, credits, tax avoidance activity, and any differences between the U.S. definition of taxable income and the foreign country definition. Table 6 uses the specification found in Table 5 and replaces the marginal corporate tax rate with the average corporate tax rate.

In Table 6, the interaction term between corporate tax rates and openness is no longer significant, as expected. In addition, Figure 3 shows that the difference between the marginal and average tax rate is positively correlated with openness. This is another indication that corporations may more actively avoid taxes in more open economies. The average corporate tax rate has a negative impact on annual gross wages, and the magnitude of this effect is similar to the effects using the marginal corporate tax rate. Results in Table 6 are noticeably more statistically significant, which may be an indication that the average tax rate is a more precise measure of the actual corporate tax rate.

4.3 By Skill-Level

The results so far have shown that labor bears at least some burden of the corporate tax. The next logical step is to ask: how is the burden divided among different types of labor? In Section 2, the capital-skill complementarity hypothesis suggested that the burden of the corporate tax should fall most heavily on high-skill labor. Table 7 gives the results of regressing annual gross wage on corporate tax rates, openness and their interaction separately for each level of skill. The coefficients on these three variables are notably consistent between middle-skill and high-skill labor. The results in Table 7 do not lend support to the hypothesis that changes to the corporate tax rate have a larger impact on high-skill labor. In fact, a one percentage point

increase in the corporate tax rate is estimated to decrease the wage of low-education labor by 0.91 percent, middle-education labor by 0.27 percent and high-education labor by 0.22 percent.

The inconclusive nature of the results in Table 7 suggests that we should look at similar results using the average corporate tax rate. These results are shown in Table 8. The coefficients on the average corporate tax rate are strikingly consistent across skill-level with a one percentage point increase in the average corporate tax rate predicted to decrease wages by 0.85 – 1.05 percent. Thus, the results do not provide support for the theory that the burden of the corporate tax falls more heavily on highly-skilled labor.

Next, I use individual data available within a country/year dataset to regress individual wage rates on education, age, age-squared and male. I run individual regressions for each country/year dataset that provides wage rates. For each country/year I use two measures of education: one including dummies for middle education and high education and another including an overall education variable valued at one for low, two for middle and three for high education. Table 9 reports the coefficients on middle and high education taken from one regression and the coefficient on overall education taken from the other for each country/year observation. These coefficients represent the return to education in a given country. The marginal and average corporate tax rates are listed in order to compare the tax rate with the return to education. Figure 4 plots the return to high education (above low) with the marginal corporate tax rate. This figure shows some evidence that the return to education is negatively impacted by the marginal corporate tax rate. Figure 5 plots the return to high education (above low) with the average corporate tax rate. This figure does not show any evidence of decreasing returns to education in response to corporate tax rates. Using the data in Table 9, I regress the return to education (middle, high, overall) on the average corporate tax rate, openness and their

interaction. These results are reported in Table 10 and find mild evidence that the average corporate tax rate affects the return to education. It is estimated that a one percentage point increase in the average corporate tax rate decreases the return to a high level of education (over low) by 0.44 percentage points.

The results presented here show little evidence that the burden of the corporate tax increases with skill-level. This contradicts the predictions drawn from the capital-skill complementarity hypothesis. One possible explanation is differences in labor mobility across skill-level. If high-skill workers are more mobile than low-skill workers, they may be able to avoid some of the corporate tax burden. These results combined with the substantial shifting of the corporate tax burden from capital to labor suggest that the incidence of the corporate tax is much less progressive than originally believed.

4.4 The Magnitude of Labor's Burden

Estimates suggest that a one percentage point increase in the average corporate tax rate, decreases annual gross wages by .9 percent. What does this imply about labor's burden of the corporate income tax? In 2000, the U.S. collected 207 billion dollars in corporate income tax revenue.[17] If the U.S. increases the average corporate tax rate from 20 percent to 21 percent and the tax base remains constant, corporate tax revenues should increase by 10.4 billion dollars. Total wages in the U.S. in 2000 were 4.8 trillion dollars; a 0.9 percent fall in total wages decreases wages by 43.5 billion dollars.[18] These data suggest that the marginal burden on labor of a one percentage point increase in the corporate income tax rate is 4.2 times the additional corporate tax revenue collected. Although this burden seems large, Harberger's (1995) estimate of labor's burden cannot be rejected in my results. The 95 percent confidence interval for

average corporate tax rates suggests that the marginal burden of the corporate tax falls between 2.35 and 6.2 times the tax revenue collected.

Harberger's finding that labor's burden of the corporate tax may be 2 to 2.5 times the size of corporate tax revenue collected reflects only labor's burden of the tax and does not include any burden from inefficiencies created by the tax. There are four potential margins from which distortions may occur from imposing a corporate tax. A corporate tax creates an inefficient allocation of capital between corporate and non-corporate firms within a country as Harberger (1962) found in a closed economy model. An open economy creates an additional distortion of capital allocation among countries. Corporate taxes create incentives for corporations to change their behavior in order to avoid taxes; these changes may create inefficiencies. If the corporate tax reduces wages and thereby reduces the return to skill, the corporate tax may create inefficiencies by distorting the acquisition of education. The estimated large burden of the corporate tax on labor is a good indication that the inefficiencies created by taxing corporations in an open economy are substantial.

5. Conclusion

The empirical results presented here suggest that the incidence of corporate taxation is more than fully borne by labor. I estimate that a one percentage point increase in the marginal corporate tax rate decreases annual wages by 0.7 percent. The magnitude of the results predicts that the decrease in wages is more than four times the amount of the corporate tax revenue collected. These empirical estimates cannot reject Harberger's (1995) theoretical estimate that labor bears 2 to 2.5 times the amount of corporate revenue collected. The inefficiencies created

by the corporate income tax suggest that the cost of raising revenue via a corporate tax may be more costly and cause more distortions in the economy than a tax on labor income.

The burden of the corporate tax on wages is shared equally across skill-level, suggesting that the corporate tax may not be as progressive as many politicians assume. Also, as the economy becomes more global, raising the corporate tax may result in lower than predicted corporate revenue increases due to the ability of firms to avoid taxes more effectively. This paper provides empirical evidence that labor's burden of corporate taxes is large as Harberger (1995) originally predicted.

[1] Auerbach (2005)

[2] Jones and Kenen (1984)

[3] Johnson and Stafford (1999)

[4] Theory predicts that corporate tax rates will have a negative effect on wage rates in an open economy. In this paper, I look at the effect of corporate tax rates on annual gross wages because of data availability. If labor is perfectly inelastic, then the effect of the corporate tax rate will be exactly the same on wage rates and annual wages. However, if labor is not perfectly inelastic, then corporate tax rates may have an impact on both wage rates and the amount of labor employed. Thus, the effect of corporate taxes on annual wages should be weakly larger than the effect on wage rates.

[5] A good review of the returns to education and the human capital earnings function can be found in Card (1999).

[6] Card (1999)

[7] The Luxembourg Income Study is currently reviewing a sixth wave of data for many countries extending the data to 2005.

[8] An education recode is not available for the following countries: Canada, Czech Republic, Hungary, Israel and United Kingdom. An education recode is not available in the early years for the following countries: Australia, Austria, Finland, France, Germany, Luxembourg, Norway, Russia, Spain, Sweden and Switzerland.

[9] I look at the effect of corporate taxes on the annual gross income of individuals as opposed to the wage rate of individuals. Data on individual wage rates is available from the LIS but several problems exist with this data. First, some countries ask individuals directly for wage rates; the accuracy of this information is questionable. More problematic is that some countries have constructed the wage rate variable from measures of annual income and hours worked. These data were constructed from either net or gross incomes, whichever is available for a specific country. Because my results are specifically concerned with the effects of taxes on wages, the measure of wage rates in the LIS data is not well-suited for my purposes.

[10] These conversions may produce a wage distribution that is more equal than the actual wage distribution. In calculating gross wages, I use the individual tax rate appropriate for the mean wage within a skill level. Therefore, high income individuals may face a higher tax rate than I use in this calculation. This will be more problematic for countries that have a highly progressive individual income tax regime.

[11] Mexico, Poland and the Slovak Republic have gross wages that are outliers. These country observations do not affect the results in this paper.

[12] In these results, I have used hourly wage rates to keep my specification as close to Hassett and Mathur's specification as possible. However, using annual gross wages in column II provides similar results.

[13] The interaction term has been entered as (openness - mean openness) multiplied by the corporate tax rate. Thus, the coefficients on the corporate tax rate are accurate as displayed in the table.

[14] The results presented in Table 5 and Table 6 are almost identical to results with a dependent variable of ln(wages) – ln(gdp per capita). For example, the coefficient on the marginal corporate tax rate is -.7356 with the ratio as the dependent variable and -.7136 with ln(wages) as the dependent variable. The coefficient on openness remains significant and negative; the coefficient on the interaction term remains significant and positive in the regressions using the marginal corporate tax rate. The coefficient on the average corporate tax rate is -.935 using the ratio as the dependent variable and -.924 using ln(wages). The interaction term is insignificant.

[15] The one exception is Mexico in 1984.

[16] For an extensive look at tax avoidance and evasion, see Slemrod and Yitzhaki (2002).

[17] Data obtained from the World Tax Database.

[18] Total wages were obtained from the Bureau of Economic Analysis.

References

Auerbach, Alan J. (2005). “Who Bears the Corporate Tax? A Review of What We Know.” *NBER Working Paper #11686.*

Bergstrom, Villy, and Epaminondas Panas. (1992). "How Robust is the Capital Skill Complementarity Hypothesis." *Review of Economics and Statistics 74(3),* 540-546.

Bureau of Economic Analysis. http://www.bea.gov/

Card, David. (1999). “The Causal Effect of Education on Earnings.” In Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics*, Vol. 3(1), 1801-1863. Amsterdam: Elsevier Science North-Holland.

Diamond, Peter A., and James A. Mirrlees. (1971). "Optimal Taxation and Public Production." *American Economic Review 61(3),* 261-278.

Fallon, P. R., and P. R. G. Layard. (1975). "Capital-Skill Complementarity, Income Distribution, and Output Accounting." *Journal of Political Economy 83(2),* 279-301.

Gravelle, Jane G., and Laurence J. Kotlikoff. (1993). “Corporate Tax Incidence and Inefficiency When Corporate and Non-corporate Goods are Close Substitutes.” *Economic Inquiry 31(4),* 501 – 516.

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?” *Advances in Economic Analysis & Policy 6(1),* article 3.

Griliches, Zvi. (1969). "Capital-Skill Complementarity." *Review of Economics and Statistics 51(4),* 465-468.

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

Harberger, Arnold. (1995). “The ABCs of Corporation Tax Incidence: Insights into the Open-Economy Case.” *Tax Policy and Economic Growth*, Washington D.C.: American Council for Capital Formation.

Hassett, Kevin A. and Aparna Mathur. (2006). "Taxes and Wages." *AEI Working Paper #128*.

Individual Taxes: A Worldwide Summary. (1984 – 2000). New York: Price Waterhouse.

IRS. *Statistics of Income Bulletin* (1988 – 2004), Publication 1136.

Ito, Hiro, and Menzie Chinn. (2006). "Notes on the Calculation of the Chinn-Ito Financial Openness Variable." Unpublished.

Johnson, George, and Frank Stafford. (1999). “The Labor Market Implications of International Trade.” In Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics*, Vol. 3(2), 2215-2288. Amsterdam: Elsevier Science North-Holland.

Jones, Ronald W., and Peter B. Kenen. (1984). “The Positive Theory of International Trade.” In Ronald W. Jones and Peter B. Kenen (eds.), *Handbook of International Economics*, Vol. 1. Amsterdam: North-Holland.

Lockwood, Ben, and Michela Redoano. (2005). *The CSGR Globalisation Index: an Introductory Guide*. Centre for the Study of Globalisation and Regionalisation Working Paper 155/04.

Luxembourg Income Study (LIS) Micro database. (2007); harmonization of original surveys conducted by the Luxembourg Income Study, Asbl. Luxembourg, periodic updating.

Mincer, Jacob. (1984). “Labor Mobility, Wages, and Job Training.” Unpublished.

Office of Tax Policy Research. (2006). *World Tax Database*, University of Michigan Ross School of Business.

Randolph, William C. (2006). "International Burdens of the Corporate Income Tax." *CBO Working Paper 2006 – 09*.

Sachs, Jeffrey D., and Andrew M. Warner. "Trade Openness Indicators." Center for International Development, Harvard University.

Slemrod, Joel and Shlomo Yitzhaki. (2002). "Tax Avoidance, Evasion, and Administration." In Alan J. Auerbach and Martin Feldstein (eds.), *Handbook of Public Economics*, Vol. 3(2), 1423-1470. Amsterdam: Elsevier Science North-Holland.

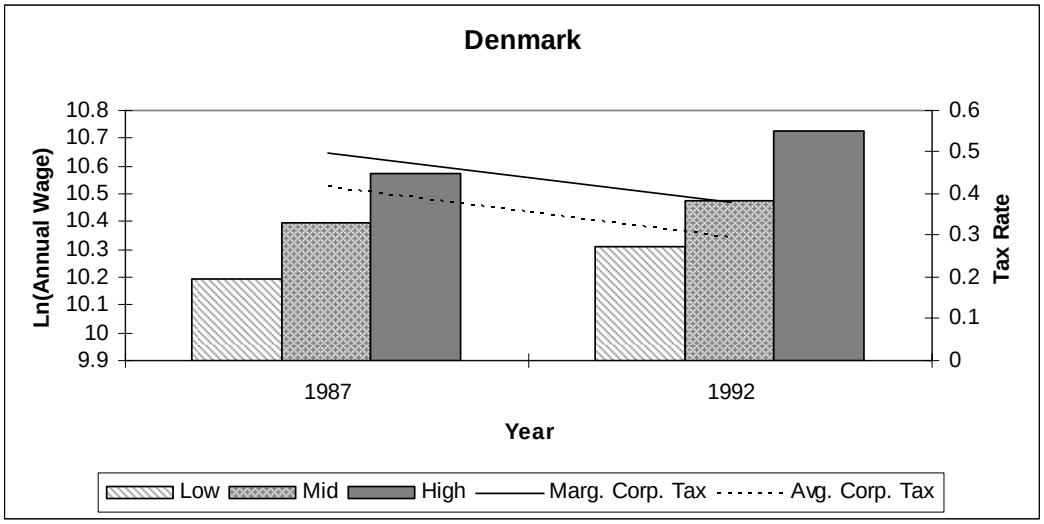
World Bank. (2006). *World Development Indicators 2006*. Washington D.C.

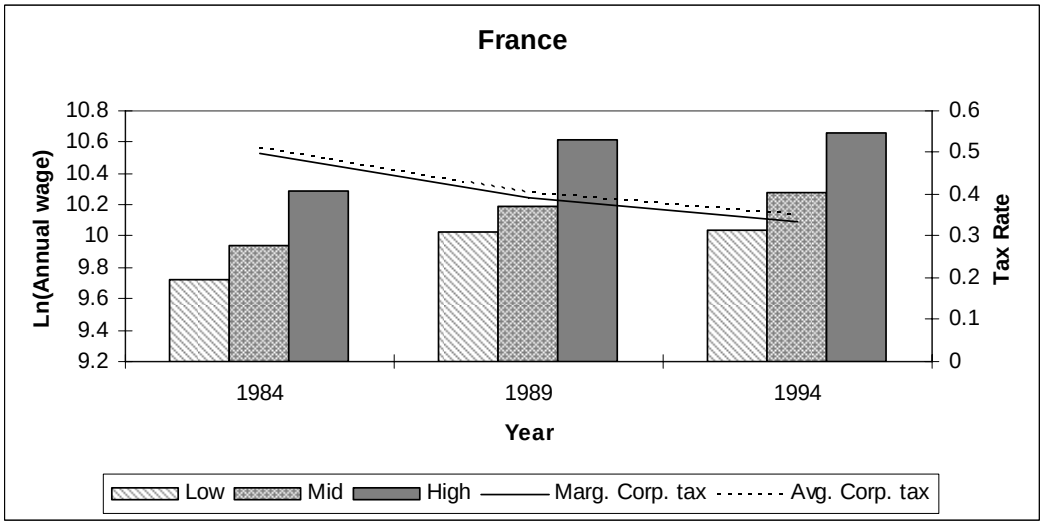
Table 1: Country/Year Observations

Australia: 1994
Austria: 1994*,1997*, 2000*
Belgium: 1985*, 1988*, 1992, 1995*, 1997, 2000*
Denmark: 1987, 1992
Finland: 1995, 2000
France: 1984*, 1989*, 1994*
Germany: 1984, 1989, 1994, 2000
Greece: 1995*, 2000*
Ireland: 1994*, 1995*, 1996*, 2000*
Italy: 1986*, 1987*, 1989*, 1991*, 1993*, 1995*, 1998*, 2000*
Mexico: 1984*, 1989*, 1992*, 1994*, 1996*, 1998*, 2000*
Netherlands: 1983, 1991, 1994, 1999
Norway: 1986, 1991, 1995, 2000
Poland: 1995*
Slovak Republic: 1992
Spain: 1990*, 1995*, 2000*
Sweden: 1992, 1995, 2000
Switzerland: 1992
United States: 1979, 1986, 1991, 1994, 1997, 2000

* Net incomes were converted into gross incomes.

Figure 1: Annual Wages and Corporate Tax Rates





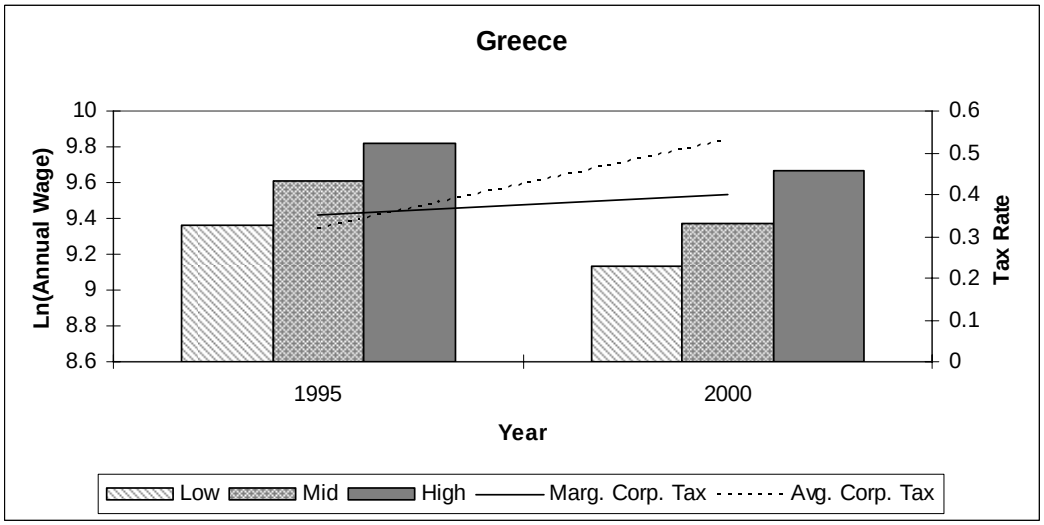
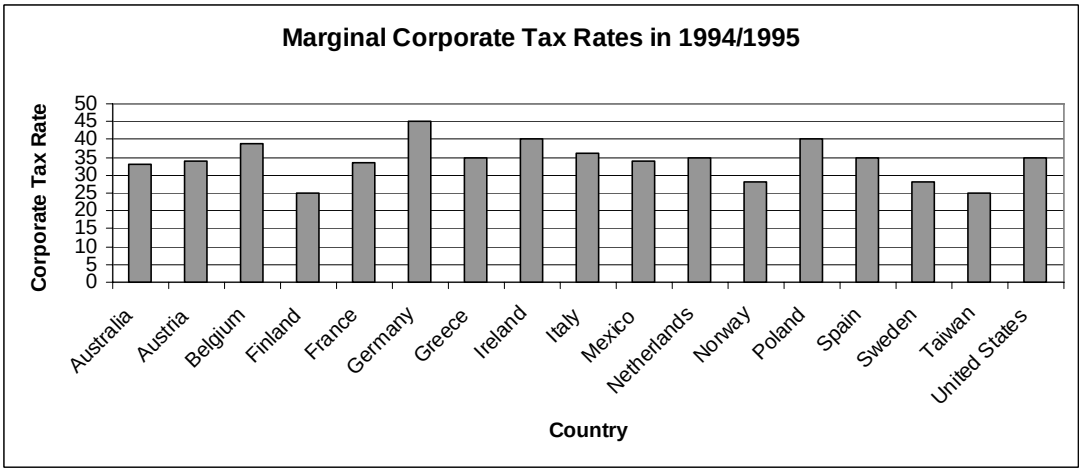


Figure 2: Gross Wages, Marginal Corporate Tax Rates and Openness Measures from 1994/1995



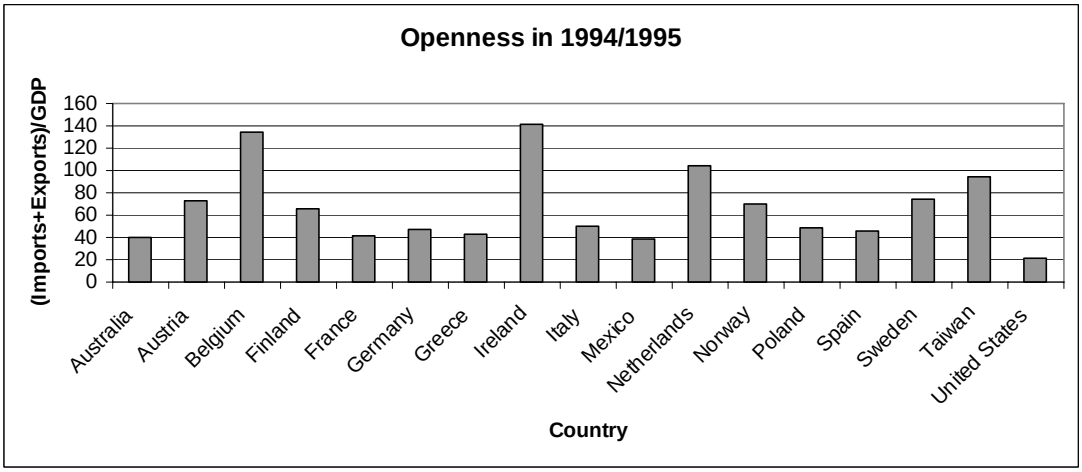


Table 2: Summary Statistics

	Mean	Std. Deviation	Observations
Gross Wage: Low Education	17,984.30	7424.78	67
Gross Wage: Middle Education	22,699.91	8685.39	67
Gross Wage: High Education	32,490.36	12770.67	67
Marginal Corporate Tax Rate	36.55%	0.0738	67
Average Corporate Tax Rate	26.83%	0.117	59
Openness: (Exports + Imports)/GDP	0.77	0.5058	67
Openness: Economic Globalisation Index	0.23	0.125	63
Openness: Chinn-Ito Financial Openness Index	1.67	1.18	58
GDP per Capita	19,222.44	8697.89	67
Unemployment Rate	8.14%	4.22	64
Personal Tax Rate	31.13%	12.49	165
Value-Added per Worker	10,415.64	4896.34	62
Consumer Price Index	80.36	21.66	65
Year	1993.37	5.19	67

Table 3: The Effect of Corporate Tax Rates and Openness on Ln(Annual Gross Wage)

	(I)	(II)	(III)
Marg. Corporate Tax Rate	-0.5499	-0.5027	-0.7063
	(.763)	(.677)	(.674)
Openness		-0.4777 ***	-0.2314 ***
		(.133)	(.083)
Low Education	-0.7169 ***	-0.7260 ***	-0.6550 ***
	(.160)	(.163)	(.179)
Middle Education	-0.3399 ***	-0.3342 ***	-0.2882 ***
	(.032)	(.033)	(.044)
Age	0.0324	0.0389	0.2325
	(.337)	(.339)	(.365)
Age-Squared	0.0001	0.0001	-0.0023
	(.004)	(.004)	(.0048)
Male	0.2240	0.1642	-0.2073
	(.173)	(.196)	(.264)
Ln(GDP per Capita)	0.9570 ***	0.9330 ***	0.5510 ***
	(.122)	(.114)	(.123)
Personal Tax Rate			0.7357 *
			(.452)
Year	-0.0200 ***	-0.0139 ***	-0.0170 ***
	(.004)	(.004)	(.005)
Constant	39.6338 ***	27.9270 ***	33.7570 ***
	(10.422)	(9.707)	(10.37)
R-Squared	0.8307	0.7292	0.7668
N	195	195	159

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 4: Comparison to Hassett and Mathur (2006)
Dependent Variable: Ln(Hourly Wage Rate in US $)

	(I)	(II)	(III)
Ln(Corporate Tax Rate)	-0.4336 **	-0.4327 **	-0.4978
	(.200)	(.201)	(.797)
Ln(Openness)		-0.3258 *	0.0391
		(.196)	(.205)
Ln(Value Added per Worker)	0.9187 ***	0.9647 ***	0.9263 ***
	(.207)	(.23)	(.219)
Ln(CPI)	0.1113 ***	0.1472 ***	0.1766 **
	(.036)	(.044)	(.085)
Personal Tax Rate			0.0659
			(.215)
Year	-0.0007	0.0055	-0.0084
	(.010)	(.008)	(.012)
Low Education	-0.6773 ***	-0.6773 ***	-0.6721 ***
	(.142)	(.143)	(.130)
Middle Education	-0.3576 ***	-0.3576 ***	-0.3522 ***
	(.039)	(.039)	(.038)
Constant	-5.4052	-18.6350	9.6036
	(20.633)	(15.231)	(23.450)
R-Squared	0.8293	0.7715	0.8368
N	108	108	96

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 5: The Effect of the Corporate Tax Rate Interacted with Openness on Ln(Annual Gross Wage)

	(I)	(II)	(III)
Marginal Corporate Tax Rate	-0.7136 **	-1.1317 **	-1.2308 **
	(.364)	(.518)	(.500)
Openness	-1.3769 ***	-1.0543 **	-1.2622 ***
	(.384)	(.461)	(.295)
(Open-mean open)*Corp. Tax	2.6970 **	2.4013 *	0.3481
	(1.06)	(1.381)	(1.10)
Low Education	-0.7421 ***	-0.6915 ***	-0.8007 ***
	(.164)	(.196)	(.160)
Middle Education	-0.3398 ***	-0.2935 ***	-0.3273 ***
	(.039)	(.051)	(.038)
Age	-0.0915	0.1040	-0.2033
	(.397)	(.440)	(.358)
Age-Squared	0.0018	-0.0006	0.0035
	(.005)	(.006)	(.005)
Male	0.1072	-0.2515	0.0417
	(.192)	(.272)	(.248)
Ln(GDP per Capita)	0.9894 ***	0.6137 ***	
	(.107)	(.126)	
Personal Tax Rate		0.4993	
		(.4078)	
Year	-0.0177 ***	-0.0207 ***	0.0069
	(.004)	(.005)	(.005)
Constant	37.8650 ***	43.6425 ***	0.1608
	(12.105)	(14.277)	(13.952)
R-Squared	0.7707	0.7877	0.0407
N	195	159	195

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 6: The Effect of the Average Corporate Tax Rate Interacted with Openness on Ln(Annual Gross Wage)

	(I)	(II)
Avg. Corporate Tax Rate	-0.9235 ***	-1.0346 ***
	(.212)	(.228)
Openness	-0.4411 **	-0.4347 **
	(.211)	(.216)
(Open-mean open)*Corp. Tax	0.0213	-0.0991
	(.542)	(.583)
Low Education	-0.7178 ***	-0.6642 ***
	(.199)	(.216)
Middle Education	-0.3097 ***	-0.2687 ***
	(.032)	(.040)
Age	0.0726	0.1363
	(.353)	(.422)
Age-Squared	-0.0003	-0.001
	(.005)	(.006)
Male	0.0314	-0.2256
	(.264)	(.278)
Ln(GDP per Capita)	0.7749	0.7265 ***
	(.125)	(.128)
Personal Tax Rate		0.5553
		(.392)
Year	-0.0184 ***	-0.0238 ***
	(.006)	(.006)
Constant	37.678 ***	47.584 ***
	(12.968)	(13.673)
R-Squared	0.7576	0.8037
N	171	141

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Figure 3: The Effect of Openness on the Difference between Marginal and Average Tax Rates

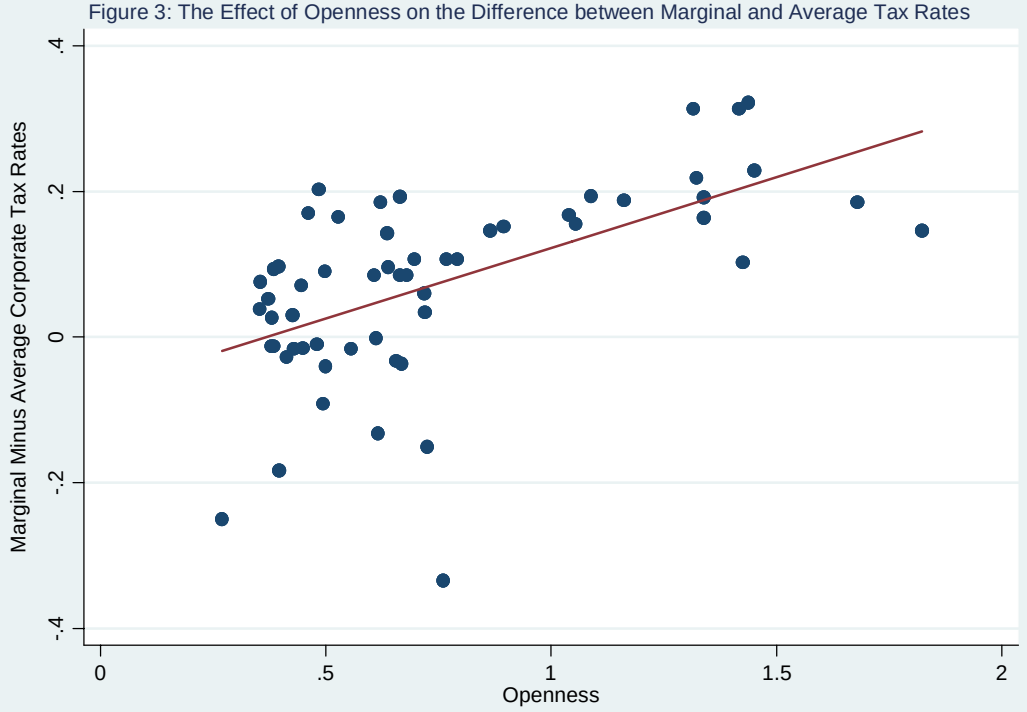


Table 7: The Effects of the Marginal Corporate Tax Rate, Openness, and Their Interaction on Gross Wages by Education: Dependent Variable: Ln(Annual Gross Wage)

	Low Education	Middle Education	High Education
Marginal Corporate Tax Rate	-0.9128 **	-0.267	-0.2206
	(.456)	(.393)	(.349)
Openness	-1.1983 ***	-1.1563 ***	-1.269 ***
	(.387)	(.408)	(.385)
(Openness- mean open)*Corp Tax	2.0026 *	2.463 ***	2.6537 **
	(1.068)	(.957)	(1.139)
Age	0.5814	0.5218	0.6236
	(.601)	(.542)	(.388)
Age-Squared	-0.0068	-0.0077	-0.0085
	(.008)	(.007)	(.005)
Male	0.4785	0.3035	0.8928 ***
	(.3896)	(.493)	(.301)
GDP per Capita	1.0908 ***	1.1114 ***	0.9977 ***
	(.116)	(.104)	(.108)
Year	-0.0218 ***	-0.0117 **	0.0043
	(.005)	(.005)	(.007)
Constant	31.613 **	14.9796	-18.561
	(12.484)	(15.293)	(18.39)
R-Squared	0.7602	0.8447	0.7864
N	65	65	65

Notes: All regressions include random effects and standard errors are clustered at the country level.
*, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 8: The Effects of the Average Corporate Tax Rate, Openness, and Their Interaction on Gross Wages by Education: Dependent Variable: Ln(Annual Gross Wage)

	Low Education	Middle Education	High Education
Average Corporate Tax Rate	-0.8522 ***	-0.8560 ***	-1.0517 ***
	(.202)	(.203)	(.232)
Openness	-0.8313 ***	-0.5169 **	-0.1189
	(.221)	(.254)	(.166)
(Openness- mean open)*Corp Tax	0.1861	0.1895	-0.2196
	(.563)	(.586)	(.511)
Age	0.6790	0.6821	0.8221 **
	(.614)	(.439)	(.333)
Age-Squared	-0.0084	-0.0091	-0.0108 **
	(.008)	(.006)	(.004)
Male	1.0062 ***	-0.6062	0.4129
	(.3251)	(.747)	(.335)
GDP per Capita	1.2582 ***	0.8855 ***	0.7331 ***
	(.253)	(.144)	(.095)
Year	-0.0192 ***	-0.0206 ***	-0.0073
	(.006)	(.007)	(.008)
Constant	22.8936 **	31.2044 ***	2.8470
	(10.497)	(12.201)	(18.202)
R-Squared	0.7740	0.7928	0.7732
N	57	57	57

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 9: Mean Country Returns to Education

Country	Year	Middle Education Return[a]	High Education Return[a]	Overall Return to Education[b]	Marg. Corp. Tax	Avg. Corp. tax
Austria	1994	0.2856	0.5605	0.2813	0.34	0.255
	1997	0.2090	0.5342	0.2587	0.34	0.234
	2000	0.2870	0.4388	0.2205	0.34	0.189
Belgium	1995	0.0958	0.3137	0.1630	0.39	0.198
	1997	0.1942	0.5685	0.2913	0.39	0.162
	2000	0.1424	0.3154	0.1600	0.39	0.205
France	1994	0.1694	0.5458	0.2617	0.50	0.510
Germany	1984	0.1562	0.3954	0.1943	0.56	0.470
	1989	0.1432	0.3991	0.1965	0.56	0.358
	1994	0.0269	0.2702	0.1558	0.45	0.280
	2000	0.1560	0.4089	0.2198	0.45	0.257
Greece	1995	0.3387	0.5819	0.2923	0.35	0.320
	2000	0.3868	0.7188	0.3601	0.40	0.532
Ireland	1994	0.2940	0.6967	0.3445	0.40	0.087
	1995	0.3251	0.6520	0.3259	0.40	0.087
	1996	0.3040	0.6944	0.3443	0.40	0.078
	2000	0.2565	0.5661	0.2819	0.24	0.094
Italy	1987	0.3152	0.6531	0.3239	0.36	0.373
	1989	0.2443	0.4164	0.2177	0.36	0.544
	1991	0.2696	0.5389	0.2695	0.36	0.308
	1993	0.3636	0.6565	0.3385	0.36	0.388
	1995	0.3462	0.6013	0.3127	0.36	0.400
	1998	0.2887	0.5347	0.2723	0.37	0.462
	2000	0.2768	0.4842	0.2502	0.37	0.386
Mexico	1984	0.7830	1.1422	0.6158	0.42	0.670
	1989	0.8125	1.1561	0.6243	0.37	0.343
	1992	0.9730	1.4735	0.7881	0.35	0.274
	1994	1.0939	1.6377	0.8761	0.34	0.247
	1996	0.9833	1.5178	0.8030	0.34	0.155
	1998	0.9790	1.5476	0.8170	0.34	0.197
	2000	0.7847	1.4187	0.7218	0.35	0.354
Netherlands	1983	0.2588	0.5594	0.2702	0.48	0.287
	1994	0.1667	0.4012	0.2004	0.35	0.183
	1999	0.2393	0.4698	0.2341	0.35	0.163
Spain	1995	0.3363	0.6973	0.3474	0.35	0.279
	2000	0.2966	0.6217	0.3097	0.35	0.352
Sweden	1995	0.0756	0.3318	0.1816	0.28	0.220
Switzerland	1992	0.1824	0.4050	0.2050	0.10	0.134
United States	1979	0.2536	0.4896	0.2435	0.46	
	1991	0.4710	0.8955	0.4406	0.34	
	1997	0.4817	0.9139	0.4485	0.35	
	2000	0.4560	0.9108	0.4552	0.35	

a. These values are estimated coefficients from the following regression that was run separately for each country/year: $wagerate_i = \alpha + \beta_1 \cdot middle\_educ_i + \beta_2 \cdot high\_educ_i + \beta_3 \cdot age_i + \beta_4 \cdot age_i^2 + \beta_5 \cdot male_i + \varepsilon$

b. These values are estimated coefficients from the following regression that was run separately for each country/year: $wagerate_i = \alpha + \beta_1 \cdot overall\_educ_i + \beta_3 \cdot age_i + \beta_4 \cdot age_i^2 + \beta_5 \cdot male_i + \varepsilon$

Figure 4: Correlation Between Returns to Education and the Marginal Corporate Tax Rate

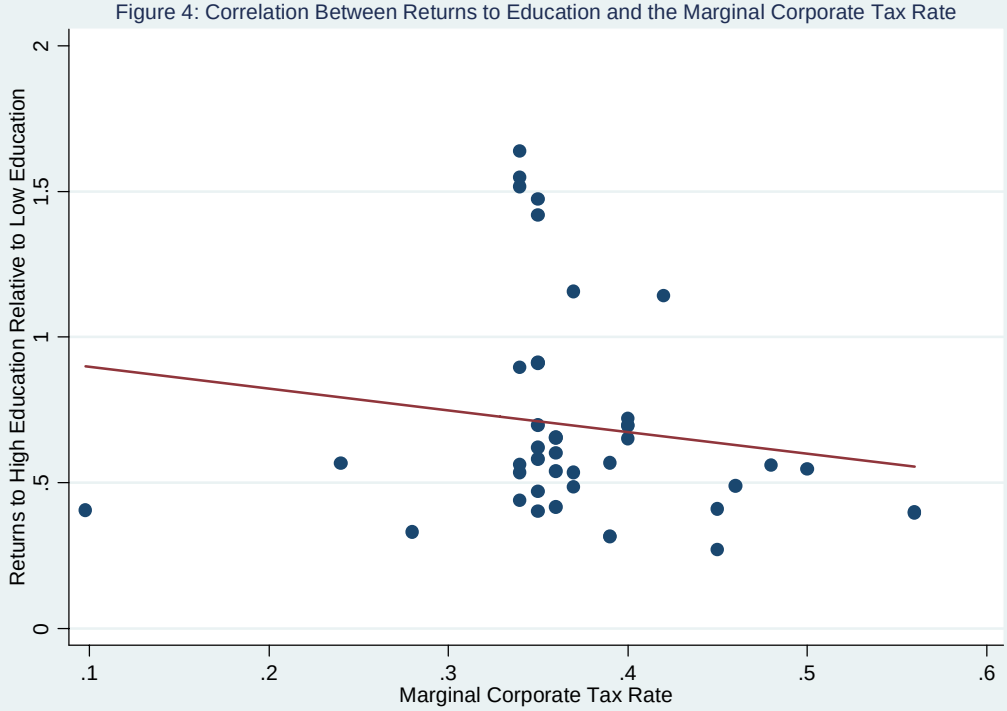


Figure 5: Correlation Between Returns to Education and the Average Corporate Tax Rate

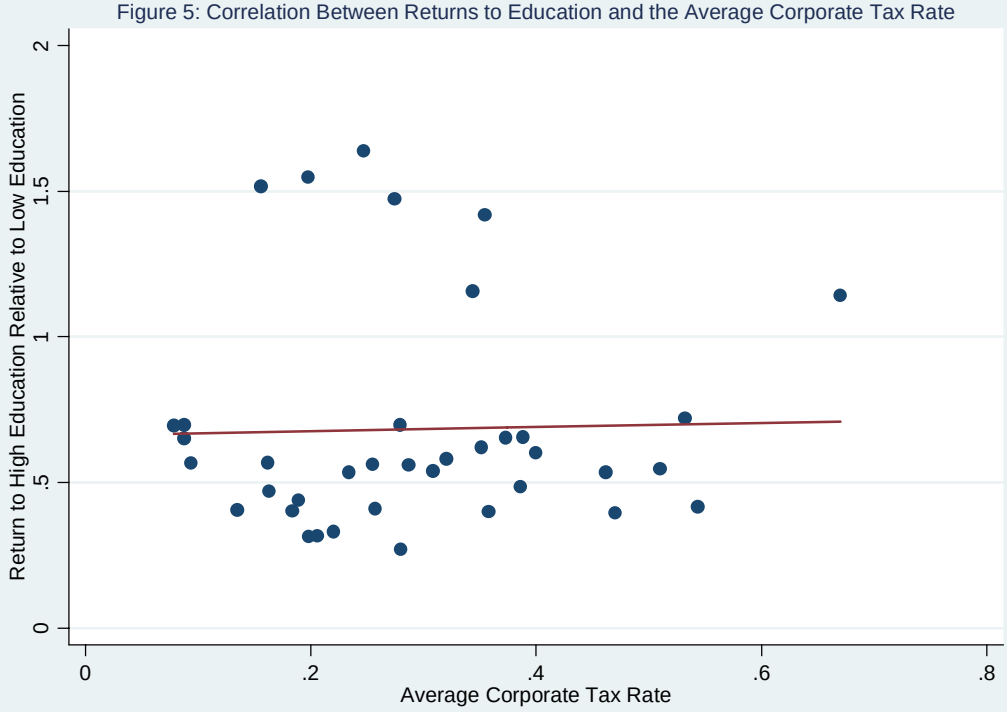


Table 10: The Impact of the Average Corporate Tax Rate on the Returns to Education

	Return to Middle Education	Return to High Education	Overall Return to Education
Average Corporate Tax Rate	-0.3122	-0.4451 *	-0.2704 **
	(.226)	(.253)	(.137)
Openness	0.0499	-0.0151	-0.0031
	(.0434)	(.0896)	(.038)
(Openness - Mean Open)*Corp. Tax Rate	-0.2000	0.1153	-0.0408
	(.3113)	(.550)	(.267)
Ln(GDP per Capita)	-0.4327 ***	-0.6051 ***	-0.3181 ***
	(.093)	(.112)	(.0633)
Year	0.0063 ***	0.0089 *	0.0050 **
	(.002)	(.005)	(.002)
Constant	-7.9989 **	-11.2765	-6.5895 *
	(3.775)	(8.602)	(3.922)
R-Squared	0.8782	0.8784	0.8863
N	38	38	38

Notes: All regressions include random effects and standard errors are clustered at the country level.
*, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix A: Derivation of Mathematical Results

Three-Level Nested CES Production Function

Production function with 4 inputs:

$$Q = \left\{ c \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{\beta}{\gamma}} + (1-c)L_3^{\beta} \right\}^{\frac{1}{\beta}}$$

Marginal productivity of labor skill-level 1:

$$\frac{\partial Q}{\partial L_1} = (1-a)bcL_1^{\theta-1} \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{(\gamma-\theta)}{\theta}} \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{(\beta-\gamma)}{\gamma}} \square$$

$$\left\{ c \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{\beta}{\gamma}} + (1-c)L_3^{\beta} \right\}^{\frac{(1-\beta)}{\beta}}$$

Marginal productivity of labor skill-level 2:

$$\frac{\partial Q}{\partial L_2} = (1-b)cL_2^{(\gamma-1)} \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{(\beta-\gamma)}{\gamma}} \square$$

$$\left\{ c \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{\beta}{\gamma}} + (1-c)L_3^{\beta} \right\}^{\frac{(1-\beta)}{\beta}}$$

Marginal productivity of labor skill-level 3:

$$\frac{\partial Q}{\partial L_3} = (1-c)L_3^{(\beta-1)} \left\{ c \left[b \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\frac{\gamma}{\theta}} + (1-b)L_2^{\gamma} \right]^{\frac{\beta}{\gamma}} + (1-c)L_3^{\beta} \right\}^{\frac{(1-\beta)}{\beta}}$$

Ratio of wages between 2 types of labor:

$$\frac{\partial Q / \partial L_1}{\partial Q / \partial L_2} = \frac{(1-a)bL_1^{\theta-1}}{(1-b)L_2^{(\gamma-1)}} \cdot \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{(\gamma-\theta)/\theta}$$

$$\frac{\partial Q / \partial L_2}{\partial Q / \partial L_3} = \frac{(1-b)cL_2^{\gamma-1}}{(1-c)L_3^{\beta-1}} \cdot \left[b\left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\gamma/\theta} + (1-b)L_2^{\gamma} \right]^{(\beta-\gamma)/\gamma}$$

The effect of a change in capital on the ratio of wages between different types of labor:

$$\frac{\partial \left(\frac{\partial Q / \partial L_1}{\partial Q / \partial L_2} \right)}{\partial K} = (\gamma-\theta) \cdot \frac{ab(1-a)}{(1-b)} \cdot \frac{(KL_1)^{\theta-1}}{L_2^{\gamma-1}} \cdot \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{(\gamma-2\theta)/\theta}$$

$$\frac{\partial \left(\frac{\partial Q / \partial L_2}{\partial Q / \partial L_3} \right)}{\partial K} = (\beta-\gamma) \cdot \frac{abc(1-b)}{(1-c)} \cdot \frac{K^{\theta-1}L_2^{\gamma-1}}{L_3^{\beta-1}} \cdot \left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{(\gamma-\theta)/\theta} \cdot \left[b\left[aK^{\theta} + (1-a)L_1^{\theta} \right]^{\gamma/\theta} + (1-b)L_2^{\gamma} \right]^{(\beta-2\gamma)/\gamma}$$

If $\beta = \gamma = \theta$, a change in capital will not affect the ratio of wages between skill types. Thus, wages across skill will be affected similarly by a change in the corporate tax rate.

If $\beta > \gamma > \theta$, a change in capital increases the ratio of wages between L_1 and L_2 and the ratio of wages between L_2 and L_3. If L_1 is high-skill labor, L_2 is middle-skill labor and L_3 is low-skill labor and the capital-skill complementarity hypothesis holds, a change in capital should have the largest effect on high-skill labor. Thus, a change in the corporate tax rate is predicted to have the largest impact on the wages of high-skill workers.

Appendix B: Measures of Openness and Their Effect on Gross Wage

Table B1: Openness Measures

		Warwick	Sachs-Warner	Chinn-Ito	(Exports + Imports)/ GDP
Australia	1994	0.135	1	2.656628	39.31
Austria	1994	0.18	1	2.374504	73.4
	1997	0.22	1	2.656628	85.24
	2000	0.312	1	2.656628	101.22
Belgium	1985	0.365	1	0.64974	141.49
	1988	0.355	1	0.64974	132.65
	1992	0.56	1	2.656628	130.38
	1995	0.376	1	2.656628	133.73
	1997	0.478	1	2.374504	144.83
	2000	0.917	1	2.374504	169.33
Denmark	1987	0.139	1	-0.05699	60.71
	1992	0.197	1	2.656628	66.43
Finland	1995	0.142	1	2.656628	66.16
	2000	0.275	1	2.656628	76.03
France	1984	0.174	1	-0.05699	46.95
	1989	0.181	1	-0.05699	44.36
	1994	0.172	1	2.656628	41.63
Germany	1984	0.174	1		57.27
	1989	0.188	1		56.52
	1994	0.175	1		46.84
	2000	0.253	1		67.07
Greece	1995	0.116	1	-0.05699	42.56
	2000	0.171	1	1.342698	57.91
Ireland	1994	0.247	1	2.09238	131.67
	1995	0.268	1	2.374504	141.23
	1996	0.267	1	2.656628	143.46
	2000	0.949	1	2.656628	175.56
Italy	1986	0.138	1	-0.05699	38.38
	1987	0.138	1	-0.05699	37.85
	1989	0.147	1	-0.05699	39.54
	1991	0.151	1	0.507263	37.11
	1993	0.174	1	2.374504	41.26
	1995	0.175	1	2.656628	50
	1998	0.219	1	2.656628	49.36
	2000	0.207	1	2.656628	55.59
Luxembourg	1997				222.25
	2000				285.59
Mexico	1984	0.147	0	-1.22844	32.24
	1989	0.151	1	-0.76088	38.06
	1992	0.158	1	-0.05699	35.51
	1994	0.156	1	1.246007	38.48
	1996	0.187	1	1.246007	62.26
	1998	0.184	1	1.246007	63.52
	2000	0.188	1	1.246007	64.69
Netherlands	1983	0.229	1	2.656628	108.04
	1991	0.238	1	2.656628	104.71
	1994	0.228	1	2.656628	103.7
	1999	0.418	1	2.656628	116.85
Norway	1986	0.164	1	-0.05699	72.85
	1991	0.15	1	-0.05699	72.62
	1995	0.148	1	1.528131	70.1
	2000	0.224	1	2.656628	77.05
Poland	1995	0.17	1		48.39
Slovak Republic	1992				138.62
Spain	1990	0.144	1	-0.05699	35.6
	1995	0.162	1	1.810255	45.39
	2000	0.25	1	1.810255	62.22
Sweden	1992	0.145	1	1.246007	54.42
	1995	0.208	1	2.09238	74.13
	2000	0.254	1	2.656628	89.02
Switzerland	1992	0.211	1		67.87
United States	1979		1	2.656628	18.94
	1986	0.153	1	2.656628	17.51
	1991	0.157	1	2.656628	20.64
	1994	0.163	1	2.656628	21.99
	1997	0.179	1	2.656628	24.5
	2000	0.187	1	2.656628	26.2

Table B2: The Effect of Different Measures of Openness on Ln(Gross Wage)

	Warwick (I)	Chinn-Ito (II)	(exports+imports)/gdp (III)
Marginal Corporate Tax Rate	-0.9129 ***	0.2526	-0.7136 **
	(.342)	(.845)	(.364)
Openness	-2.1977 ***	-0.2911 *	-1.3769 ***
	(.335)	(.177)	(.384)
(Open - Mean Open)*Corp. Tax	4.659 ***	0.8503 *	2.697 **
	(.913)	(.467)	(1.06)
Low Education	-0.7411 ***	-0.729 ***	-0.7421 ***
	(.166)	(.175)	(.164)
Middle Education	-0.3382 ***	-0.3053 ***	-0.3398 ***
	(.038)	(.031)	(.039)
Age	-0.0625	0.1929	-0.0915
	(.374)	(.359)	(.397)
Age-Squared	0.0014	-0.0017	0.0018
	(.005)	(.005)	(.005)
Male	0.1222	-0.1063	0.1072
	(.209)	(.284)	(.192)
Ln(GDP per Capita)	0.8903 ***	0.685	0.9894 ***
	(.124)	(.120)	(.107)
Year	-0.0168 ***	-0.0174 **	-0.0177 ***
	(.004)	(.009)	(.004)
Constant	36.083	34.142 *	37.865 ***
	(11.198)	(18.438)	(12.105)
R-Squared	0.7838	0.6506	0.7707
N	189	174	195

Notes: All regressions include random effects and standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.