

Country characteristics and the incidence of capital income taxation on wages: An empirical assessment

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Abstract. This paper examines the incidence of corporate income taxes on wages using data from the US Bureau of Labor Statistics for 13 OECD countries. Within a wage-bargaining framework, our econometric analysis shows that a substantial share of the corporate tax burden is shifted from capital to labour. However, the magnitude of this shift is influenced importantly by country characteristics affecting the process of wage determination, such as the degree of capital mobility, a country's relative influence over the world price of output and trade unions' strength.

Résumé. *Caractéristiques des pays et incidence de la fiscalité sur les revenus de capital sur les salaires : une évaluation empirique.* Ce mémoire examine l'incidence des impôts sur les revenus des corporations sur les salaires à l'aide de données du Bureau of Labor Statistics pour 13 pays de l'OCDE. Dans le cadre d'un modèle de négociation des salaires, une analyse économétrique montre qu'une portion substantielle du fardeau des impôts sur le revenu des corporations est déplacée du capital vers le travail. Cependant la magnitude de ce déplacement est influencée de manière importante par les caractéristiques du pays qui influencent le processus de détermination des salaires comme le degré de mobilité du capital, l'importance relative d'un pays sur le prix mondial de son extrant, et la forces des syndicats.

JEL classification: H22, H25, H32, H87

We are grateful to Alan Auerbach and Jane Gravelle for excellent comments and suggestions. We would like to acknowledge the valuable feedback provided by participants at the Royal Economic Society annual conference in Cambridge, the seminar of the University College Dublin and the seminar of the University of Loughborough.
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1. Introduction

The economic burden of a tax on capital income does not mechanically fall upon the shareholders who have the statutory liability for paying the tax to the fiscal authorities. Knowing who actually bears the burden of the capital income tax is crucial for understanding both the progressivity of the tax system and inefficiencies caused by distortions in the allocation of capital. Following and extending the seminal work of Harberger (1962) to the case of an open economy, more contemporary analyses of the corporate tax burden using a framework in which wages are based on labour productivity have consistently concluded that domestic labour bears a sizeable share of a corporate income tax increase, ranging from 70% (Randolph 2006) to 250% (Harberger 1995). One exception is Gravelle and Smetters (2006) who, by relaxing both assumptions of perfect demand substitution between domestic and foreign internationally tradeable goods and of perfect capital mobility, find that labour bears only 21% of the burden. Tax burden analysis based on a framework in which wages are set through a bargaining process finds that 50% of the burden is directly shifted to labour (Arulampalam et al. 2012). Without considering factors that can influence the mobility of capital in particular or the bargaining power of firms and trade unions in general, most empirical studies find results consistent with theoretical models in which capital is perfectly mobile and domestic and foreign products are perfect substitutes—that is, labour bears most of the tax burden.

This paper re-examines the extent to which corporate taxes are shifted to labour in the form of lower wages. Following Arulampalam et al. (2012), our empirical analysis is based on a wage-bargaining framework, which allows the identification of the direct incidence of corporate taxes on wages conditional on value-added. We extend the research on corporate tax incidence in two important ways. First, the paper replicates the analyses of existing empirical studies by using for the first time the database of the Bureau of Labor Statistics, which is one of the most reliable database on labour costs and productivity (International Labour Office 2009). This database is prepared specifically to allow international comparisons of labour costs and productivity in the manufacturing sector and is available for 13 OECD countries. Furthermore, while previous work has focused mainly on either country-level data or firm-level data, we consider data at the sectoral level. This intermediate position in identifying corporate tax incidence comes from the fact that most countries negotiate wages at the sectoral level.

Second, the understanding of who bears the burden of the corporate income tax is uneven from a theoretical and an empirical perspective. Theoretical research sheds light on factors influencing the magnitude of the shift, but the empirical studies are scarce and are limited to an homogeneous average shift across countries. Thus, the second contribution of the paper is to allow for the magnitude of the shift to diverge by country characteristics based on or extending lessons from the two existing theoretical frameworks, namely “wages based on labour productivity” and “wages set through a bargaining process.” We explore the extent to

which the degree of shifting of capital taxation on labour can be explained by the degree of mobility of capital, a country's relative influence over the world price of output and trade unions' strength.

To begin, the theoretical studies focusing on effects through labour productivity show that, in a closed economy, capital bears the full tax burden; in an open economy, however, the domestic owners of capital can avoid most of the corporate tax burden by reallocating capital abroad. The openness of a country is, then, a crucial characteristic in determining who bears the corporate tax burden. These analyses are silent about the relationship between the magnitude of the shift of the tax burden and the degree of openness of a country. Under a wage-bargaining framework, an increase in capital openness should affect the relationship between corporate taxes and bargained wages as it increases the bargaining power of the firm. We test this prediction by considering the effect of the extent and intensity of capital controls on the wages and corporate tax rates elasticity.

In addition, the theory based on effects through labour productivity predicts that in smaller open economies, in which the higher tax burden cannot be absorbed through a general worldwide decline in the rate of return to capital nor reflected in a rise of the price level of the products, the degree of shifting to wages should be higher than in larger open economies. Under a wage-bargaining framework, a decrease in the size of a country should translate into an increase in the outside options of the firms, decreasing the size of the profit over which firms are prepared to bargain. We test this prediction by interacting the corporate tax rate with a measure of the relative size of a country in the world capital market and with a measure of the relative size of a country in the world market supply.

Third, countries diverge in the ways in which they tax capital income. One would expect the shifting of corporate taxation to workers to be larger in countries allowing capital allocation to be diverted by taxes (as this increases firms' outside options), such as under tax-exempt systems where the corporate income tax is source-based, than in countries trying to limit capital distortions induced by tax considerations, such as under tax-credit systems where the corporate income tax is residence-based. We can test this assumption by distinguishing tax-credit systems from tax-exempt systems when investigating the effect of corporate taxes on wages. Finally, within the wage-bargaining framework, other relevant country characteristics that can influence the magnitude of the shift are those related to the bargaining power of the trade union. This feature can be taken into account by considering measures of trade unions' strength. The effect of unions' strength on the shift is ambiguous as unions face a trade-off between a higher wage level and reduced inequality, the latter being achieved via a compression of wages generally from below.

Conditional on value-added per worker, our baseline equation indicates that an increase of corporate tax rate by one percentage point reduces wages by 0.1%. Using data on GDP, corporate tax revenue and labour income as a share of GDP, we calculate that this semi-elasticity corresponds to a 60% direct shift of the corporate tax burden to labour on average for the 13 OECD countries. In

addition, there is evidence that the magnitude of the shift is strongly influenced by the mobility of capital, a country's ability to influence the price of tradeables and union density. We find that the domestic labour's burden will be higher, the higher the degree of capital openness, the higher the density of unions and the lower the relative position of a country in the world capital market and in the world market supply.

The paper is organized as follows. The next section reviews related research. Section 3 discusses the role played by the degree of capital openness, country size, the tax system and trade unions' strength in the relationship between corporate taxes and wages. Section 4 presents the data sources, the methodology and descriptive statistics. Section 5 presents the results, section 6 provides a discussion on wage adjustments and section 7 offers concluding remarks.

2. Related research

2.1. Theoretical analysis with wages based on labour productivity

The first paper to provide a theoretical framework for the analysis of the incidence of corporate income taxes on wages is Harberger (1962). This seminal model of a closed economy with two factors and two sectors (one corporate and the other non corporate), indicates that corporate income tax is not shifted to labour but is fully borne by capital. In this model, labour and capital are fixed, but perfectly mobile between sectors. An increase in taxes in the corporate sector reduces the after-tax return and drives capital into the non corporate sector, thus reducing the non corporate after-tax return. In equilibrium, the after-tax returns in both sectors must be equal. Producers' and consumers' substitution decisions combine in such a way that the decrease of the new equilibrium after-tax return corresponds to the amount consistent with owners of capital (both corporate and non corporate) bearing the entire burden of the corporate income tax.

Rising volume of capital and trade flows has triggered an analysis in the context of an open economy. In the two country models developed by Bradford (1978) and Kotlikoff and Summers (1987), capital is assumed to be perfectly mobile between countries and labour is immobile. These authors show that an increase in corporate tax rates induces a shift of capital from this country to other countries to escape the additional tax burden. This decline of capital results in a lower productivity of labour in the home country, reducing wages and, leading to workers bearing a substantial share of the corporate income tax burden. Randolph (2006) and Harberger (1995; 2006) develop a general equilibrium model to analyze the long-run incidence of capital taxation in an open economy and provide a quantification of the amount of the tax burden that is shifted to the labour force. Under the assumptions that capital is perfectly mobile internationally and that there is a perfect demand substitution between domestic and foreign tradeable goods, Harberger (1995) predicts that labour bears 2 to 2.5 times the US corporate tax

burden.¹ This prediction is based only on changes in the source of income. With a measure of the burden that combines the source and the use of income, Randolph (2006) finds that domestic labour and domestic owners of capital bear the tax burden roughly in proportion to their factor income shares in the economy—that is, labour bears slightly more than 70% of the corporate tax burden. With the same measure of the burden but with different assumptions about the US economy,² Harberger (2006) reports a higher shift, finding that domestic labour bears between 96%, with some separability in world and domestic product prices, and 130%, with perfect product substitution, of corporate income taxes.

The incidence of a rise in the corporate tax depends crucially on the basic assumptions in the model.³ In particular, relaxing the hypothesis of perfect demand substitution between domestic and foreign tradeable goods can modify the predictions of open economy tax incidence models. Considering that tradeable goods are not perfect substitute across countries, Gravelle and Smetters (2006) introduce imperfect competition in a general equilibrium model and show that most of the burden is borne by domestic capital, a result close to the one of Harberger (1962) closed-economy model.⁴ Indeed, if consumers are less disposed to substitute between foreign and domestic goods, capital will be less sensitive to corporate tax differentials. Their model effectively show that the decrease in capital mobility increases the share of the tax burden that falls on capital. A rise in the mobility of labour would lead to the same result. Harberger (2006) and Randolph (2006) general equilibrium models make the assumption that capital is mobile internationally and that labour is immobile. As emphasized by Gentry (2007), this type of model obviously results in labour—the less mobile factor—bearing the burden of the corporate income tax.

2.2. *Theoretical analysis with wages set through a bargaining process*

Arulampalam et al. (2012) propose a second mechanism through which corporate income taxes can influence real wages: the wage bargaining. They consider a model where the firm and a single union bargain over both wages, w , and employment, N . The level of capital, K , is chosen simultaneously by the firm. Employees have an outside wage available, \bar{w} (alternative job or unemployment benefit), and the firm has an outside profit, Π^* , if it shifts its activities to another location or activity. The domestic post-tax profit is:

- 1 As emphasized by Gravelle and Smetters (2006), however, by considering nominal wages, Harberger (1995) does not quantify the effects on the prices of other goods. A fall in nominal wages does not imply a shift to labour of the burden if there is a decrease in the average prices of products consumed by domestic workers.
- 2 In particular, the assumption of capital intensity in the corporate tradeable sector compared to the rest of the economy.
- 3 See Gravelle (2010) for a good explanation of what drives these models.
- 4 By relaxing the product substitution elasticity (to 3), they predict that labour bears 55% of the tax burden. By relaxing the portfolio substitution elasticity (to 3) they find that labour bears 28% of the burden. When both elasticities are relaxed (are 3), the tax burden borne by labour decreases to 21%.

$$\Pi = F(K, N) - wN - rK - T. \quad (1)$$

$F(K, N)$ is a revenue function with F interpreted as value-added. The cost of capital is rK and T is the tax on corporate income, levied at rate τ , with:

$$T = \tau\{F(K, N) - wN - \alpha rK\} + \phi, \quad (2)$$

where α is a measure of the level of depreciation allowances and ϕ is a term including factors affecting the firm tax burden (for example loss carried forward or transfer pricing manipulations).

Wages and employment are determined by a Nash bargain maximizing:

$$B = \{[u(w) - u(\bar{w})]N\}^{1-\mu} \{\Pi - \Pi^*\}^\mu. \quad (3)$$

The union maximizes $(u(w) - u(\bar{w})N) - u(\cdot)$ being the utility of a single worker — with a bargaining power $1 - \mu$, which may depend on an alternative income to the workers in case of dispute. The bargaining power of the firm, μ , may depend on the cost of a dispute.

For a given pre-tax economic rent, an increase in corporate tax rate reduces the post-tax economic rent over which the firm and the union will bargain. The wage determination depends on the bargaining power of both the firm and the union and on the outside options of both the firm and the worker. Holding all the other activities of the firm fixed, Arulampalam et al. (2012) find that an increase in corporate tax liability is shared by the firm and the workers. This result corresponds to the *direct incidence* of corporation tax on wages. The *total incidence* would be obtained by allowing the firm to adapt its level of capital, employment and output price to a change in corporate taxes.

2.3. Empirical evidence

With the exception of Arulampalam et al. (2012), the results of the empirical literature are consistent with general equilibrium models based on an open economy with perfect competition.⁵ With different methodologies, three papers, Hassett and Mathur (2006), Felix (2007) and Desai et al. (2007) conclude that labour bears the major share of the corporate income tax burden. Hassett and Mathur (2006) investigate the incidence of various measures of corporate tax rates on manufacturing wages across 72 developed and developing countries between 1981–2002. They use the Labor Statistics database provided by the International Labor Organization (ILO). Controlling for value-added and trade openness, they find that labour is substantially affected by corporate tax rates. Indeed, an increase in the statutory corporate tax rate of 1%, decreases wages by 0.95% on average across the estimations. Felix (2007) analyzes the impact of corporate income taxes on gross wages in 19 industrialized countries between 1979–2002, using the Luxembourg Income Study database. Corporate tax rates appear to have a statistically significant negative impact on wages only when, using her data, Felix (2007) estimates the Hassett and Mathur (2006) specifications. She finds that a one percentage

5 See Auerbach (2006) and Gentry (2007) for a detailed review on the incidence of corporate income taxes.

point increase in the corporate tax rate decreases annual wages by 0.43%.⁶ Distinguishing low-, middle- and high-skill workers, it appears that the incidence of corporate taxes on wages is not statistically different across skill level.

Desai et al. (2007) investigate the same relationship but with aggregate data on US multinational firms operating in 50 countries for the years 1989, 1994, 1999 and 2004. They jointly estimate the incidence of corporate taxes on the ratio of total employee compensation (including benefits) and return to capital and find that between 45% and 75% of the burden is borne by labour, the remaining part being borne by capital. In the models set by Hassett and Mathur (2006), Felix (2007) and Desai et al. (2007), corporate tax rates are supposed to affect wages through the first mechanism considered by theoretical models, that is through the decrease of investment and the resulting decrease in labour productivity. Arulampalam et al. (2012) underline that controlling for value-added, as it is done in Hassett and Mathur (2006), does not allow to insulate the effect of taxes that comes from changes in capital intensity (the value-added variable and the tax variable being related). Hassett and Mathur (2006) overcome this limitation with a two-step procedure that confirms their intuition where taxes can influence the capital-labour ratio in the first stage and where the capital-labour ratio can affect wages in the second stage.

Arulampalam et al. (2012) test the incidence of corporate taxes via the wage bargaining mechanism they have developed. They measure the size of the direct effect by using firm-level data for the period 1996–2003 in nine European countries. To interpret their results as resulting from the bargaining mechanism, they include as control the value-added per worker (which captures the capital intensity mechanism that affects productivity). They find that a one-dollar increase in the corporate tax burden, decreases total wages by 49 cents in the long run. They also distinguish multinational firms from domestic firms with the assumption that being multinational increases firm's bargaining power and outside options, as the firm can shift its production abroad. They find, however, that the magnitude of the elasticity between corporate taxes and total wages depends only marginally on the multinationalization of the firm.

3. Country characteristics and tax incidence

Our analysis differs from previous empirical work in several important aspects. We consider that countries are not homogenous by allowing the elasticity between

⁶ Felix (2007) estimates several other specifications controlling for openness, GDP per capita, education, age and gender and finds that corporate tax rates have a statistically significant effect on wages only when an interaction term between taxes and trade openness is included in the regression. She concludes that a one percentage point increase in corporate tax rates decreases wages by 0.7% to 1.2%. However, by simply examining the coefficient of corporate taxes, Felix (2007) incorrectly concludes that taxes have a negative effect on wages. This coefficient measures the effect when openness equals zero. For a more meaningful value of openness such as its mean (0.77), the results indicate surprisingly that a one percentage point increase in corporate taxes increases wages by 1.37%.

corporate taxes and wages to diverge depending on certain country characteristics such as the degree of capital openness, the size of a country, its tax system and its trade union force. These testable characteristics have emerged by establishing bridges between the two theoretical frameworks previously discussed, namely “wages based on labour productivity” and “wages set through a bargaining process.”

3.1. Openness

The tax incidence theory based on labour productivity predicts that having an open economy is likely to shift the corporate tax burden from capital to labour. But to what extent does the degree of openness matter? If the degree to which a country is open to capital has an influence on the mobility of capital flows, one might expect that the magnitude of the tax burden that is shifted from capital to labour would increase with a country degree of openness. The same effect would be expected within a wage bargaining framework, as easing the mobility of capital increases a firm's fallback profit (Π^*) by providing the firm with more outside options. In addition, easing capital mobility decreases the cost of shifting activities abroad when the firm is in a dispute with workers. This change increases the bargaining power of the firm (μ). The effect of capital openness on the elasticity between corporate taxes and wages is tested in the empirical part.

3.2. Small country effect

Harberger (2006) provides a simple framework to investigate the incidence of an increase in corporate taxes through changes in factor prices and product prices for a small open economy and a large open economy. He considers an economy with a product a in a tradeable sector with a price-formation equation incorporating a tax on capital T_{Ka} :

$$dp_a = f_K(dp_K + T_{Ka}) + f_L dp_L, \quad (4)$$

where f_K and f_L are the shares of capital and labour in the production costs of a .

In a *small open economy*, in which capital is perfectly mobile internationally, labour is fixed and immobile and the worldwide capital stock is fixed, the burden of a tax imposed on capital will fall entirely on labour. Indeed, the corporate income tax temporarily decreases the return to capital. Capital flows out of the country to escape taxes until the domestic pre-tax return is increased so that the new domestic after-tax return is equal to the previous one. Therefore, with a small open economy that is a price-taker for tradeables and in the world capital market, $dp_a = dp_K = 0$, so that:

$$0 = f_K T_{Ka} + f_L dp_L. \quad (5)$$

If we assume that the initial prices are set to be equal to 1, then $f_K = K_a/a$ and $f_L = L_a/a$. Therefore, equation (5) becomes:

$$L_a dp_L = -K_a T_{Ka}. \quad (6)$$

A small open economy is a small part of the world market and is unable to influence its terms of trade by its own actions nor the return to capital. If the price of the product a , p_a , cannot increase and the return to capital p_K cannot decrease, this is labour that has to bear the entire corporate tax burden to maintain the activity of a . Therefore, p_L decreases by an amount consistent with labour bearing the entire corporate income tax.

Consider now a *large open economy* in which labour is immobile, capital is perfectly mobile and the worldwide capital stock is fixed. The corporate tax incidence is different than in a small open economy because placing a tax on capital in a large economy can decrease the world rate of return. As in the small open economy, the lower domestic after-tax return caused by the implementation of the corporate income tax, drives capital abroad. However, with a higher proportion of the world's capital stock, the decrease of the domestic rate of return will generate a worldwide decline in the return to capital. Domestic capital flows abroad until the pre-tax rate of return abroad is reduced, equalizing then the rates of return around the world. In other words, placing a tax on capital results in a decrease of p_K , which spreads to all capital. In a large economy, the burden of the tax is therefore also borne by capital and the decrease in p_L should be smaller than in a small open economy. The difference in the tax burden borne by labour in a large economy, as compared with a small economy, is strengthened by the fact that even under the assumption of homogeneous products, the large open economy can shift part of the tax burden on the price of the product. By exporting large quantities of products that are in strong demand, a large economy can influence the price it charges and therefore have a non negligible impact on world prices. Part of the tax burden will be then reflected in a rise of p_a .

Harberger's (2006) framework indicates that in smaller open economies, in which the higher tax burden cannot be absorbed through a general worldwide decline in the rate of return to capital nor reflected in a rise of the price level of the products, the degree of shifting to wages is higher than in larger open economies. This hypothesis should translate in a higher elasticity between corporate tax rates and wages for smaller open economies under both the labour productivity and the wage bargaining frameworks. Indeed, the mobility of capital from large open economies, as compared to small open economies, is limited by the fact that capital cannot completely escape the burden of the corporate tax since the decrease of the domestic rate of return will generate a worldwide decline in the return to capital. In other words, the outside options and the bargaining power of a firm are decreasing with the size of a country in the world capital market. Considering now a country's ability to influence the price of tradeables, an increase of the firm's output price would not endanger the activity of the firm in a large country. Contrary to the small economy scenario, where the decrease of wages is the only possibility to maintain the activity of the firm, the existence of this potential passthrough of the corporate tax in large economies is expected to weaken the bargaining position of the firm in their ability to negotiate lower wages. We test this prediction by interacting the corporate tax rate with a measure of the relative

size of a country in the world capital market and with a measure of the relative size of a country in the world market supply.⁷

3.3. *Tax systems*

As emphasized by Auerbach (2006), the analysis of the corporate income tax incidence is made more complex by the tax treatment of cross-border capital flows. The intuition of open-economy theoretical models is simple: capital is reallocated abroad in response to the increase in the corporate tax rate to avoid the additional tax burden. However, in practice, the incentive to benefit from lower taxes abroad can be significantly limited when capital is taxed on a residence basis as compared to a source basis. Indeed, a pure worldwide tax system, also called a tax-credit system, would not distort the decision about whether to locate investment at home or abroad, since companies would be subject to taxation on all income regardless of where that income is earned. Double taxation of the foreign income is avoided by allowing investors to claim foreign tax credits for income taxes paid in the host country, up to the home statutory tax rate. Conversely, exempt tax systems calculate corporation tax only on profits made by firms operating domestically, regardless of their nationality. Consequently, profits earned abroad are not subject to the home country corporation tax.

It is worth noting that worldwide tax systems are generally hybrid as they combine elements consistent with capital-export neutrality and with capital-import neutrality (Keightley and Sherlock 2012). For instance, the possibility to defer taxes until income earned abroad is remitted as dividends to the home country, and/or the possibility (such as in the United States) to use the total worldwide foreign income of the taxpayer to calculate the foreign tax-credit limit, provide an incentive to locate in low-tax jurisdictions. Indeed, tax deferral increases the reinvestment in each period (when the foreign taxes are lower than the home country statutory tax rate) and thus increases the net cumulative profit at the end of the period. By averaging foreign tax liabilities, the cross-crediting method provides an incentive for “excess credit” investors to locate activities in low-tax countries, because taxes imposed by a high-tax country can be used to offset home-country taxes on income earned by the same tax payer in the low-tax country. However, these systems also contain provisions to limit the incentive to locate in low-tax countries, such as anti-deferral regimes for passive income and various sales and service activities, or cross-crediting limitations that allow averaging within basket only. Taking these features in combinations, one would expect the shifting of corporate taxation to workers to be larger in countries allowing capital allocation to be diverted by taxes, than in countries trying to limit capital distortion due

⁷ Note that introducing imperfect product substitution, as in Gravelle and Smetters (2006), allows even a small open economy to shift part of the tax burden in a rise in p_a relative to p_a^* the external price level. With a rise in p_a , the decrease in wages, p_L , is less important than with a scenario of homogeneous products. In an economy with both homogeneous products and differentiated products, we can, however, infer that, following an increase in corporate taxes, dp_L will remain higher in a small economy than in a large economy, simply because in a large economy the price of both homogeneous and differentiated domestic outputs can rise.

to tax considerations. Again, under a wage-bargaining framework, more capital mobility facilitates firms generation of outside options and should strengthen their position in the wage bargaining with unions. We test this prediction by distinguishing tax-credit systems from tax-exempt systems when investigating the effect of corporate taxes on wages.

3.4. *Trade unions' strength*

Within the wage-bargaining framework, a country characteristic of direct relevance is the extent of the trade union presence. Trade union presence can either be measured by the proportion of employees that belong to the union (union density) or by the proportion of employees with a wage negotiated by the union (union coverage). While most studies use both measures interchangeably, Fitzenberger et al. (2008) argue that density corresponds to a pre-bargaining indicator and coverage to a post-bargaining indicator for unions' power. They consider that union density is a better measure for unions' strength as unions' funding, enabling the union to financially support workers during strikes, increases with the number of union members paying membership fees. As the length of a potential strike is directly related to union density, Fitzenberger et al. (2008) emphasize that "union density governs a union's threat point in the collective bargaining process and is therefore pivotal to the bargaining outcome," (p. 4). Union coverage corresponds to the application of the bargained wage.

Theoretical models on wage-setting behaviour generally predict a positive relationship between unions' strength and the level of wages. However, a negative relationship can be established when an insurance provision is introduced to a typical wage-bargaining model (Agell and Lommerud 1992; Burda 1995; Fitzenberger et al. 2008). This insurance provision allows to reduce the members' exposure to risk when their income can be affected by aggregate shocks common to all firms, such as an increase in corporate taxes, idiosyncratic shocks, such as a demand shock on the firm's products, or intrinsic uncertainty concerning individuals' skill characteristics. Under uncertainty, unions contribute to the welfare of risk-averse members by bargaining for a compression of the wage distribution relative to the productivity distribution. As emphasized by Fitzenberger et al. (2008), this compression of wages is generally done from below as the wage bargained serves as a wage floor. The attempt to equalize wages and to prevent negative effects on employment can lead to adverse effects on the level of wages. With a degree of wage compression increasing with the bargaining power of unions, a higher union density can be negatively correlated with the level of wages.

Another country characteristic of potential relevance is how unions are organized. Studies on unions' ability to coordinate or centralize wage bargaining tend to observe a negative relationship between the level of wages and the degree of unions coordination and centralization. This observation comes mainly from studies investigating the impact of a higher total tax wedge — that is, the sum of employer, employee and indirect tax rates, on gross wages or total compensation costs. Within this framework, countries are usually distinguished according

to their wage bargaining structure, as it is expected that the economy-wide employment implications of higher labour costs (Calmfors and Driffill 1988) and/or workers' perception of the link between the taxes they pay and the benefits that they receive (Summers et al. 1993; Alesina and Perotti 1997) increase with the degree of centralization and coordination of wage bargaining. For the present analysis — analyzing a change in corporate taxes and not in payroll taxes — highly centralized and coordinated trade unions are expected to take into account the implications of their decisions in terms of unemployment (which, in theory, might occur if capital and production are delocated abroad). Thus, they should be more likely to allow a shift of the tax burden to workers to compensate the increase of taxes on corporate income by a decrease in labour costs. Here again, unions' strength is not necessarily associated with raising wages.

We test the potential effect of union density, union coverage and the degree of centralization and coordination of unions on the incidence of corporate taxes on wages. Among these measures of unions' strength, we expect union density to be the most relevant determinant of the magnitude of the tax burden shift as it represents the most direct measure of the bargaining power of unions. The sign of the interaction term is ambiguous as unions face a trade-off between a decrease in inequality and a higher wage level. Under an insurance motive of union representation, the preference for wage equality, and by extension the degree of wage compression, increases with union density, which should be accompanied by a lower wage level. Thus, a higher shift of the corporate tax burden to wages can be expected. Similarly, if the economy-wide employment implications of higher corporate taxes increase with the degree of centralization or coordination of unions, the magnitude of the tax burden shifted to labour should increase with the degree of centralization or coordination of unions.

4. Empirical model and data description

We estimate the relationship between corporate taxation, wages and the country characteristics discussed in section 3, using annual data on the manufacturing sector for a panel of 13 OECD countries: Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States. The period covered is 1980–2004, with some exceptions depending on data availability.

4.1. Basic model

The basic specification we estimate is based on standard theoretical wage bargaining models, such as Wulfsberg (1997), and is of the form:

$$\begin{aligned} \text{Ln(Wage)}_i^t = & \alpha_i + \beta_1 \text{Statutory Tax Rate}_i^t + \beta_2 \text{Ln(Value-added)}_i^t \\ & + \beta_3 \text{Ln(GDP per capita)}_i^t + \beta_4 \text{Trade openness}_i^t \\ & + \beta_5 \text{Unemployment rate}_i^t + \beta_6 \text{Price Wedge}_i^t + \lambda_t + \epsilon_i^t, \end{aligned} \quad (7)$$

where α_i denotes country-specific fixed effects, λ_t denotes time dummies, and ϵ_i^t is the error term.

The real hourly wage is expected to be negatively related to the corporate statutory tax rate (STR) and to be positively and closely related to the hourly value-added, which proxies for labour productivity. GDP per capita and trade openness are incorporated into our model in order to capture time-varying factors that may influence wages, such as labour market institutions or the increased competition from developing countries in the production of goods intensive in unskilled labour. Signs of both variables are ambiguous. A boost in employment and output can be achieved through a reduction in the bargaining power of workers (fall in the replacement ratio) or in the market power of firms (increase in the degree of product-market competition), leading to changes in the real wage diametrically opposite despite similar outcomes. Higher trade openness may be due to larger imports, larger exports, or both, with each scenario having a different impact on labour demand. Larger unemployment rate should have a negative effect on wages as the growing lack of outside opportunities reduces the bargaining power of workers. Finally, workers evaluate the wage offers in terms of purchasing power that they will deliver, implying that a wedge between the consumer price index (CPI) and the producer price index (PPI) is likely to raise wage pressures.

The dependent variable is the average hourly direct pay per worker in the manufacturing sector as computed by the Bureau of Labor Statistics. Values come from the underlying 2006 revised data used by the BLS to construct trend indexes and annual percent changes of output per hour, hourly compensation, unit labour costs in manufacturing for sixteen countries. Data have been prepared specifically to allow international comparisons of labour costs and productivity in the manufacturing sector and have been described by the International Labour Organisation as the most reliable available series (International Labour Office 2009). The hourly direct pay corresponds to all payment made directly to the worker, before payroll deductions, consisting in pay for time worked and other direct pay such as holidays, seasonal bonuses, pay in kind (Bureau of Labor Statistics 2006). The explanatory variable value-added also comes from the BLS and corresponds to the average value-added per worker in manufacturing. Both measures have been deflated by the manufacturing producer price index (PPI, base year 2000) given in the OECD Factbook 2007. The unemployment rate series come from the IMF World Economic Outlook database (October 2008), the consumer price index (CPI, base year 2000) from the World Bank Development Indicators database, while trade openness (sum of exports and imports divided by GDP)⁸ and income per capita come from the Penn World Table v6.2 (Heston

8 With this volume type measure of trade openness, we do not consider the fact that the threat of trade is sufficient for the overseas markets to impact domestic markets. Indeed, goods do not need to actually move between two countries for the law of one price to hold. That said, it is not unreasonable to expect the threat of trade to be correlated with trade openness.

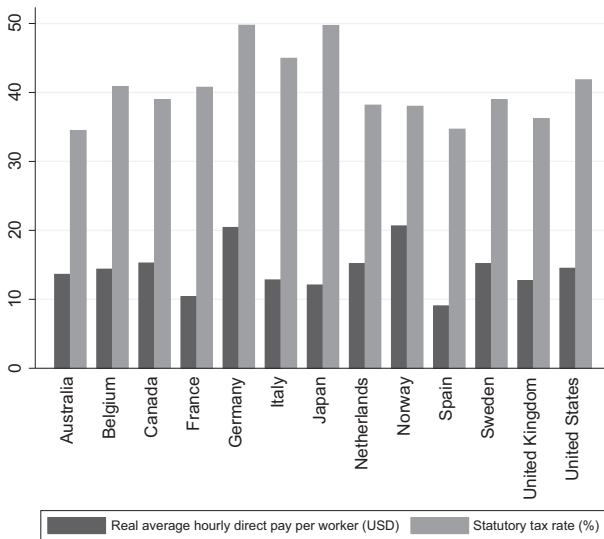


FIGURE 1: Wages and statutory tax rates (average for the period 1980–2004)

NOTES: The average hourly direct rates of pay per worker in the manufacturing sector are from the BLS and are deflated by the manufacturing producer price index (PPI, base year 2000) given in the OECD Factbook 2007. The corporate statutory tax rates are taken from Devereux et al. (2002).

et al. 2006). The corporate statutory tax rates are taken from Devereux et al. (2002).

Figure 1 presents the real average hourly direct rates of pay per worker and the statutory tax rate for each country of the sample. Wages and the level of corporate taxes vary substantially from one country to another, with higher wages in Germany and Norway (approximately \$20 per hour) and higher levels of corporate tax rates in Belgium, France, Germany, Italy, Japan and the United States (with a statutory tax rate higher than 40%), on average for the 1980–2004 period. Figure 2 shows the average trend of wages and corporate taxes for the 13 OECD countries of the sample between 1980 and 2004. The average level of wages was around \$11 per hour in 1980 and was about \$19 per hour in 2004. The average level of corporate taxes was close to 47% in 1980 and had decreased by approximately 13 percentage points to 34% in 2004.

Figure 3 shows the total distribution of changes in the statutory tax rate between 1980 and 2004 for the group of 13 OECD countries. This figure indicates that the statutory tax rate does not display homogeneous within-country variations for the period examined. In two decades, the 13 countries of the sample have changed their statutory tax rate 86 times, leading to an average within-country change of 6.6 times. The changes are frequently small, as 80% of the changes are less than or equal to five percentage points. Countries such as Canada, France, Germany, Italy, Japan and the United Kingdom have experienced a higher number of changes than the average. Only one or two changes have occurred for

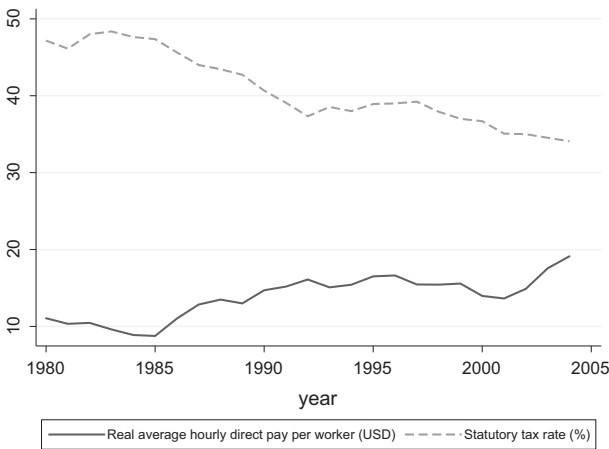


FIGURE 2: Wages and statutory tax rate trends over the period 1980–2004 (average for 13 OECD countries)

NOTES: The average hourly direct rates of pay per worker in the manufacturing sector are from the BLS and are deflated by the manufacturing producer price index (PPI, base year 2000) given in the OECD Factbook 2007. The corporate statutory tax rates are taken from Devereux et al. (2002).

Spain, Norway and the United States. Figure 4 plots these changes of statutory tax rates alongside the changes of the log of real wages for the 13 countries of the sample.⁹ A change in the statutory tax rate is generally accompanied by a change, in the opposite direction, of the log of real wages. This pattern holds for all type of changes, small and large, positive and negative, of the statutory tax rate. If we take Australia for instance, the large decline of the STR in 1988 (–11 percentage points) is accompanied by an increase in wages in the same year. In addition, the more moderate increases in STR in Canada in 1995 (+2 percentage points) and in France in 1995 (+4 percentage points) are both accompanied by a decline in wages in the same year. More generally, all the increases in statutory tax rates are accompanied by a decrease in wages or at least a slowdown of wage growth in the same period. This figure provides two interesting insights in the relationship between the tax burden and wages. First, it gives some evidence that

9 The dependent variable used in the paper is the logarithm of the real average hourly direct pay per worker in the manufacturing sector. This variable is denominated in US dollars. For the graphical depiction in figure 4, we plot statutory tax rate changes alongside changes in the logarithm of real wages in national currency to remove changes in wages that are due to an appreciation or a depreciation of the dollar. The dependent variable being denominated in US dollars is not an issue for the empirical analysis as the model includes time dummies that capture an appreciation or a depreciation of the dollar against the other currencies. In addition, the price wedge, which is the difference between the consumer price index and the producer price index, controls for the changes in purchasing power that are induced by an appreciation or a depreciation of the national currency. As a robustness check, we included the logarithm of the nominal exchange rate as a control in the model. In addition, we conducted the same analysis with the logarithm of real average hourly direct pay per worker in national currency as a dependent variable. The results are validated in both cases — that is, they confirm that the statutory tax rate has a negative effect on wages with an estimated coefficient statistically significantly different from zero at the 1% level. These results are available upon request.

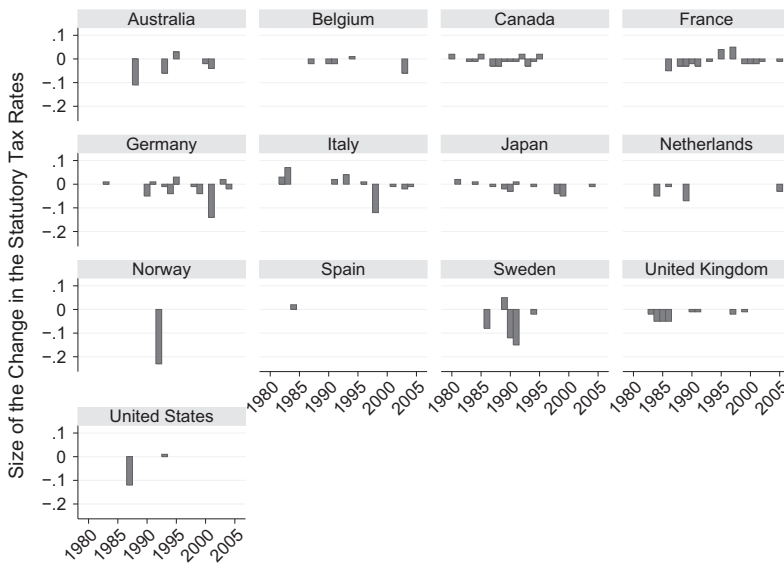


FIGURE 3: Changes in statutory tax rates

NOTE: The corporate statutory tax rates are taken from Devereux et al. (2002).

these changes in corporate tax rates are linked and may drive changes in wages. Second, the effects on wages are quick, as changes in corporate taxes and in wages generally happen within the same period.¹⁰

Finally, as the minority of larger corporate tax rate changes might influence the results, we provide more information about other tax changes that accompanied these changes in particular. In table 1, we report the 11 larger statutory tax rate changes (higher than five percentage points) occurring in the analysis and the corresponding changes of personal income tax rate, value-added tax rate and non-wage labour cost tax rate (percentage of direct pay) incurred by employers. The personal income tax (PIT) rate is the top statutory marginal personal income tax rate and it is provided by Sabirianova Peter et al. (2009). The value-added tax (VAT) rate come from the OECD and the non-wage labour cost (NWLC) tax rate come from the Bureau of Labor Statistics. As table 1 shows, five out of 11 large statutory tax rate changes are accompanied by large changes in personal income tax rate. Within a wage bargaining framework, an increase in the personal income taxes is likely to raise real wage pressures (before tax) as unions want to maintain

10 An important related point is whether changes in the statutory tax rate translate into changes in the effective tax rates firms faced. If a change in the statutory rate does not translate into real changes in corporate tax bills, any correlation with a change in wages could be spurious. In figure A1 in the appendix, we plot together the changes in statutory tax rates and the changes in effective average tax rates. Both variables exhibit very similar trend for each country of the sample. In addition, changes in statutory tax rates appear to be translated very quickly into changes in effective average tax rate. The correlation between both variables is 0.9 for the sample and period covered in the analysis.

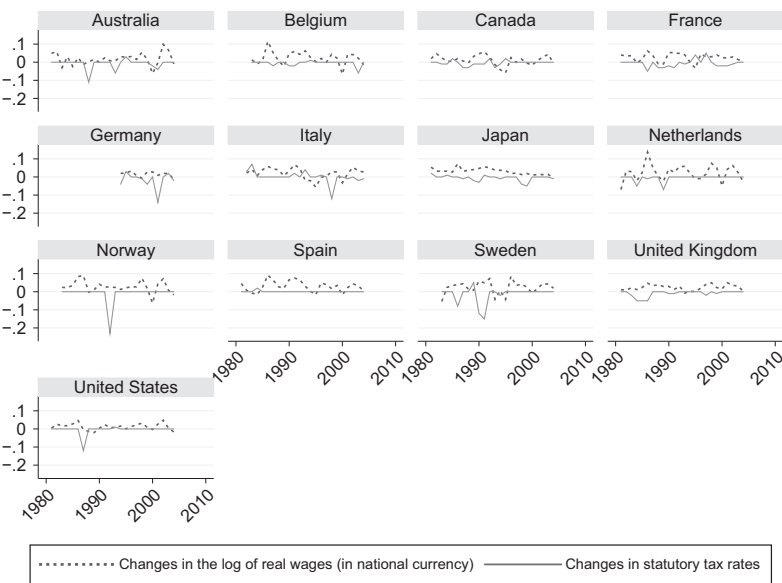


FIGURE 4: Changes in statutory tax rates and in the log of real wages
NOTE: The corporate statutory tax rates are taken from Devereux et al. (2002).

the purchasing power of workers (Lockwood and Manning 1993). Thus, the statutory tax rate and the personal income tax rate are expected to have opposite effects on wages. The negative relationship suggested by the previous figures 2 and 4 between wages and statutory tax rates indicate that this relationship is driven by changes in statutory tax rates and not by changes in personal income tax rates. Unfortunately, the VAT data are not available for six out of 11 observations. However, the available data show that large changes in statutory tax rates are not accompanied by changes in VAT rates. In addition, the data provided by the OECD, over the period 1976–2013, indicate that the VAT rate does not change often and does not experience large changes in magnitude.¹¹ The non-wage labour cost tax rate incurred by employers could be problematic as an increase of the tax burden can be shifted from employers to workers (Daveri and Tabellini 2000; Gruber 1997; Summers et al. 1993; Alesina and Perotti 1997). However, table 1 indicates that large changes in statutory tax rates are not closely related to changes in non-wage labour costs.

11 For instance, between 1980 and 2004, the VAT rate has increased by five percentage points in Belgium, three percentage points in Germany, five percentage points in Italy, one percentage point in Netherlands, four percentage points in Norway and one and a half percentage points in Sweden. The data are available only from 2002 for Australia, and the VAT rate is constant until 2004.

TABLE 1

Percentage changes in statutory tax rate (STR), personal income tax (PIT) rate, value-added tax (VAT) rate and non-wage labour cost (NWLC) tax rate (percentage of direct pay)

Country	Year	STR	PIT	VAT	NWLC % of direct pay
Australia	1988	-11	-8.08	-	0
Australia	1993	-6	0	-	0.03
Belgium	2003	-6	-3	0	0.02
Germany	2001	-14	-2.5	0	0
Italy	1998	-12	-5	-	-3.37
Netherlands	1989	-7	0	-	-1.32
Norway	1992	-23	-10.5	0	-0.02
Sweden	1986	-8	0	0	0
Sweden	1990	-12	-7	-	-1
Sweden	1991	-15	-15	-	1.9
United States	1987	-12	-11.5	n.a.	0.35

NOTES: The statutory tax rate (STR) data are from Devereux et al. (2002). The personal income tax (PIT) rates are provided by Sabirianova Peter et al. (2009). The value-added tax (VAT) rates come from the OECD and the non-wage labour cost (NWLC) tax rates come from the Bureau of Labor Statistics.

4.2. Country characteristics

In the second step of the exercise, we examine the effects of some country characteristics on the relationship between corporate taxes and wages. In particular, we estimate the following equation:

$$\begin{aligned} \text{Ln(Wage)}_i^t = & \alpha_i + \beta_1 \text{Statutory Tax Rate}_i^t + \beta_2 \text{Ln(Value-added)}_i^t \\ & + \beta_3 \text{Ln(GDP per capita)}_i^t + \beta_4 \text{Trade openness}_i^t \\ & + \beta_5 \text{Unemployment rate}_i^t + \beta_6 \text{Price Wedge}_i^t \\ & + \beta_7 (\text{Statutory Tax Rate}_i^t * Z_i^t) + \beta_8 Z_i^t + \lambda_t + \epsilon_i^t. \end{aligned} \quad (8)$$

That is, we add to the baseline equation (7) above an interaction term between the statutory tax rate variable and Z_i^t , corresponding in turn and then simultaneously to one of the following country characteristics: capital openness, small country effect (that is, financial assets, export share and export share in manufacturing), tax system (that is, a dummy for tax-credit countries) and unions' strength (that is, union density, union coverage, the degree of bargaining coordination and the degree of bargaining centralization).

Capital openness. We use the index created by Chinn and Ito (2008), which measures the degree of openness in capital account transactions by considering the extent and intensity of capital controls. This variable is a de jure measure of capital openness, as it considers regulatory restrictions on capital. The index is a principal component of four variables on the restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions: a variable indicating the presence of multiple exchange rates ($k1$); a variable indicating restrictions on current account transactions ($k2$);

a variable indicating restrictions on capital account transactions ($k3$);¹² and a variable indicating the requirement of the surrender of export proceeds ($k4$).

Financial assets. Empirically, the size of a country, or the extent to which a country is a price-taker in the world capital market, can be measured by its position in the international financial integration (Lane and Milesi-Ferretti 2007). We use a measure of external financial assets position provided by Lane and Milesi-Ferretti's (2007) External Wealth of Nations Database to capture a country's ability to influence the world return to capital. This variable corresponds to the ratio of financial assets of a country i to the world financial assets. Financial assets are composed by portfolio investment (subdivided into equity securities and debt securities), foreign direct investment (equity participations above 10%), debt (portfolio debt securities, plus bank loans and deposits and other debt instruments) and financial derivatives (market value of the outstanding derivatives' contracts).

Export share. The size of a country, or the extent to which a country is price-taker for tradeables, can be measured by its export shares. As emphasized by Carbaugh (2009), an economy whose exports constitute a very small portion of the world market supply may be thought of as a small country that faces a constant world price level for its exported commodities. Export share is our measure of a country's ability to influence the world price of output and corresponds to the ratio of a country i 's exports of goods and services to the world exports of goods and services.¹³ These data come from the World Bank. This measure facilitates measuring the aggregate incidence of a change in corporate taxes on wages, which can be mitigated when a higher tax burden can be reflected in a rise of the price level of the products. Even if each of the 13 countries we consider in this analysis has some market power for a few commodities, what matters when considering the change in price as a pass-through for an increase in corporate taxes is the country's ability to influence the price in world markets for the majority of their commodity exports. However, because the tax incidence analysis focuses on the manufacturing sector, we use an alternative and narrower measure: the export share in manufacturing.

Export share in manufacturing. The export share in manufacturing is our second measure of a country's ability to influence the world price of output and corresponds to the ratio of a country i 's exports of goods and services in manufacturing to the world exports of goods and services in manufacturing. These data come from UNCTAD.

Dummy variable for tax-credit countries. This dummy variable takes the value one if the country has a tax-credit system (Belgium, Italy, Japan, Norway, Spain, Sweden, the United Kingdom and the United States) and the value zero if the

12 More precisely, ($k3$) represents the share of a five-year window (encompassing year t and the preceding four years) that capital controls were not in effect.

13 A similar measure is used in Chen et al. (2010) to illustrate the extent to which the countries they focus on are price takers for the vast majority of their commodity exports.

country has a tax-exempt system (Australia, Canada, France, Germany and the Netherlands).¹⁴

Finally, the extent of unions' strength and organization are measured by four variables coming from Ochel (2001) and the OECD (2004) "The CEP-OECD Institution Data Set." Union density and union coverage measure the extent of a union's presence; bargaining coordination and bargaining centralization measure how a union is organized.

Union density. Net union density is the number of union members divided by employment. The measure was calculated using administrative and survey data from the OECD labour market statistics database.

Union coverage. Union coverage corresponds to the number of workers covered by collective agreements normalized on employment. The data were constructed as an interpolation of both the Ochel (2001) and the OECD (2004) data.

Bargaining coordination. This measure is an index of bargaining coordination with range [1, 5], averaged over the sample period, taken from OECD (2004), table 3.5. It is increasing in the degree of coordination in the bargaining process on the employers' as well as the unions' side.¹⁵

Bargaining centralization. This measure is an index of bargaining centralization with range [1, 5], averaged over the sample period, taken from OECD (2004), table 3.5. It is increasing in the degree of centralization.¹⁶

Union density data are available until 2002. Union coverage, bargaining coordination and bargaining centralization data are available until 2000. Table 2 shows that the design of the wage-setting system and union's strength vary substantially from one country to another. The bargaining centralization index, which is higher than one for most of the countries of the sample, indicates that wages are bargained mainly at the industry level. Summary statistics are presented in table 3.

14 To distinguish between tax-credit systems and tax-exempt systems, we use the PriceWaterHouseCooper-HSBC "Doing Business" reports and the Deloitte "International Tax and Business Guide." In Belgium, Italy, Japan, Norway, Spain, Sweden, the United Kingdom and the United States, resident companies are subject to corporate income taxes on their worldwide profits. Non-resident foreign companies having a permanent establishment in Australia, Canada, France, Germany or Netherlands, such as a branch or a subsidiary, are exempt to income taxes in the home country.

15 As defined by the OECD (2004), "1" corresponds to fragmented company/plant bargaining, little or no coordination by upper-level associates; "2" corresponds to fragmented industry and company level bargaining, with little or no pattern-setting; "3" corresponds to industry level bargaining with irregular pattern-setting and moderate coordination among major bargaining actors; "4" corresponds to (a) informal coordination of industry and firm-level bargaining by peak associations; (b) coordinated bargaining by peak confederations, including government-sponsored negotiations or government imposition of wage schedules; (c) regular pattern-setting coupled with high union concentration and/or bargaining coordination by large firms; (d) government wage arbitration; and "5" corresponds to (a) informal coordination of industry-level bargaining by an encompassing union confederation; (b) coordinated bargaining by peak confederations or government imposition of a wage schedule/freeze, with a peace obligation.

16 As defined by the OECD (2004), "1" corresponds to company and plant level predominant; "2" corresponds to a combination of industry and company/plant level, with an important share of employees covered by company bargains; "3" corresponds to an industry level predominant; "4" corresponds to predominantly industrial bargaining, but also recurrent central-level agreements; and "5" corresponds to central-level agreements of overriding importance.

TABLE 2
Union centralization, density, coverage and coordination in selected OECD countries: Average 1980–2004

	Centralization	Density (%)	Coverage (%)	Coordination
Australia	2.95	40.67	82.59	3.07
Belgium	3.00	53.84	91.04	4.14
Canada	1.00	34.01	36.83	1.00
France	2.00	11.94	91.49	2.00
Germany	3.00	30.99	85.63	4.00
Italy	2.36	39.94	83.39	3.17
Japan	1.00	25.66	23.00	4.00
Netherlands	3.00	26.75	79.40	4.12
Norway	4.26	56.97	71.04	4.26
Spain	3.36	12.50	74.40	3.36
Sweden	3.36	82.45	86.61	3.12
United Kingdom	1.00	39.19	50.40	1.00
United States	1.00	15.86	18.60	1.00

NOTE: The data are from OECD (2004) and Nickell (2006).

TABLE 3
Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Ln wage	309	2.5914	0.3406	1.4480	3.3179
Ln value-added	311	3.3567	0.3373	2.2007	4.0435
Ln GDP per capita	325	9.9699	0.2017	9.3847	10.494
Trade openness	321	60.2333	33.6573	15.9949	168.0267
Unemployment rate	324	0.0781	0.0393	0.0156	0.2412
Price wedge	311	−0.0648	0.1101	−0.4066	0.1136
Statutory tax rate (STR)	319	0.4149	0.0904	0.28	0.63
Capital openness	324	1.7907	1.0176	−1.8556	2.4557
Export share	325	0.0465	0.0335	0.0081	0.1353
Export share manufacturing	312	4.7054	3.3902	0.7340	12.8066
Financial assets	271	0.0545	0.0587	0.0025	0.2395
Ln union density	294	3.4366	0.5854	2.001	4.4705
Ln union coverage	273	4.0959	0.5356	2.6391	4.5539
Bargaining coordination	325	2.9414	1.2197	1	4.2619
Bargaining centralization	325	2.4066	1.0645	1	4.2619

5. Empirical results

5.1. The incidence of corporate tax rates on wages

Table 4 presents the results of the baseline equation (7). We have removed outliers using a Cook’s *D* test.¹⁷ Column 1 indicates that the estimated coefficients on value-added, price wedge and trade openness variables have the predicted signs and are statistically significantly different from zero. Therefore, higher labour productivity or a positive price wedge are associated with higher wages. Trade

17 The results are not affected by outliers. The basic regression without outliers (corresponding to the column 1 of table 4) plotted in figure A2 in the appendix produces results very close to those of same regression with outliers plotted in figure A3 in the appendix.

TABLE 4
The incidence of corporate tax rates on wages

	Direct incidence (1)	Overall incidence (2)	Instrumentation* IV 2nd lag STR (3)
Ln value-added	0.8487 ^a (0.0196)	— —	0.8798 ^a (0.0269)
Ln GDP per capita	0.5198 ^a (0.0897)	0.4745 ^c (0.2647)	−0.2937 ^b (0.1429)
Trade openness	−0.0013 ^b (0.0006)	−0.0099 ^a (0.0016)	−0.0025 ^a (0.0007)
Unemployment rate	0.4244 ^b (0.1727)	−0.1493 (0.5083)	−0.8832 ^a (0.2521)
Price wedge	0.8673 ^a (0.0818)	2.0056 ^a (0.2288)	0.4942 ^a (0.1027)
STR	−0.1088 ^c (0.0584)	−0.4336 ^b (0.1711)	−0.1143 (0.1726)
Constant	−4.8990 ^a (0.8889)	−0.7843 (2.6095)	0.0150 ^c (0.0078)
Observations	286	286	254
R-squared	0.9786	0.8129	0.9671
Autocorrelation test AR(1) p-value			0.8746
Autocorrelation test AR(2) p-value			0.6261
Cragg-Donald Wald F statistic			22.285
Exogeneity test p-value			0.1498

NOTES: The letters “a,” “b” and “c” indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included. The price wedge corresponds to $\ln(CPI) - \ln(PPI)$. *We estimate the first-difference of equation (7) using two-stage least squares, in which the first-difference of the tax variable has been instrumented by its second lag in column 3.

openness has a negative effect on wages; an effect that can be interpreted as a consequence of the increased competition from developing countries in the production of unskilled manufacturing goods. The positive sign of the coefficient on GDP per capita indicates that growth in OECD countries has been partly achieved by an increase in the degree of product-market competition, which has weakened the bargaining power of firms. Unexpectedly, the estimated coefficient on the unemployment rate is positive and statistically significant in column 1. This result is, however, not robust across the regressions.

By controlling for value-added in column 1, we estimate the direct effect of corporate tax rates on wages through the wage-bargaining channel. The estimated coefficient on the statutory tax rate variable has the expected negative sign, but it is statistically significantly different from zero only at the 10% level. The magnitude of this coefficient indicates that a one percentage point increase in corporate taxes decreases wages by approximately 0.1%. The most comparable results of other empirical studies are those of Hassett and Mathur (2006) and Arulampalam et al. (2012), because they both control for labour productivity. Using aggregated data from 72 developed and developing countries over the 1981–2003 period, Hassett

and Mathur (2006) find that a one percentage point increase in the statutory tax rates leads to a fall in wages by 0.8% to 1%. In their report for Congress, Gravelle and Hungerford (2007) calculate that with a corporate tax revenue collected at about 2.5% of GDP and a labour income at about two thirds of GDP, such an elasticity implies that a one dollar increase in corporate tax would reduce wages by 22 to 26 dollars.¹⁸ For comparison, for the 13 OECD countries in 2004, on average, corporate tax revenue represented 3.7% of GDP, labour income about two thirds of GDP and the statutory tax rate was at 34%.¹⁹ With a mean GDP of 2.243 trillion dollars and assuming a constant tax base, an increase of one percentage point of the statutory tax rate (from 34% to 35%), which decreases wages by 0.1%, implies that a one dollar increase in taxes reduces wages by 60 cents. With a different identification, this result is very close to the one obtained by the firm-level analysis of Arulampalam et al. (2012). Under their wage bargaining framework, Arulampalam et al. (2012) find that a one dollar increase in taxes decreases wages by 50 cents for a sample of nine European countries²⁰ over the period 1996–2003.

The inclusion of the value-added in column 1 does not allow us to measure the indirect effect of corporate taxes on wages — that is, through a change in the capital stock affecting the level of pre-tax profit. One can estimate an overall effect, accounting for both the direct incidence and the indirect incidence via a change in capital stock, by removing the value-added variable. By removing the intervening variable, the decline of capital that lowers the level of pre-tax profit should be captured by the statutory tax rate coefficient whose absolute size is expected to increase. Column 2 presents an estimate of the incidence of corporate taxes on wages when the value-added variable is deleted. With a semi-elasticity of -0.43 , the magnitude of the tax coefficient is higher in column 2 than in column 1 and its level of statistical significance is higher. We interpret this result with caution because this estimation suffers from an omitted variable bias. The omitted value-added variable is correlated with the statutory tax rate (-0.35), so the latter variable is correlated with the error term. Nevertheless, we can estimate the direction of the bias. With $\beta_1 < 0$ and a negative correlation between the statutory tax rate and the value-added, OLS with the statutory tax rate alone overstates the effect of corporate taxes on wages. As in Betts (1995), when investigating the relationship between high school quality, education and

18 According to Gravelle and Hungerford (2007), the improbable magnitude of their results can be explained by an inappropriate measure of the wage variable, which is in nominal terms. By replicating Hassett and Mathur (2006) tests with a real wage variable, Gravelle and Hungerford (2007) obtain a lower estimated coefficient (-0.51) that is less statistically significant. The measure of the value-added variable, which is calculated from three different sources, can be an additional reason for these large effects. If the value-added variable used diverges from the true value-added variable, the corporate tax coefficient is likely to capture part of the indirect effect of taxes on wages through changes in the capital stock.

19 The data on corporate tax revenue as a percentage of GDP come from the OECD.

20 These countries include Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

earnings, one can think of the coefficient of the tax variable as an upper bound of the effect on wages.

The magnitude of the labour's burden can again be calculated using average values (for our 13 OECD countries) of GDP (2.243 trillion dollars), corporate tax rates (34%) and corporate fiscal receipts as a share of GDP (3.7%) for 2004 with a labour income of about two thirds of GDP and a constant tax base. With these values, the semi-elasticity of -0.43 between wages and corporate taxes implies that a one dollar increase in taxes decreases wages by \$2.65. This result indicates a strong distributional effect, as the decrease in wages is higher than the additional tax revenues collected by the government. We can infer from these back-of-the-envelope calculations that labour bears more than the full burden of the corporate income tax when the coefficient estimated for the statutory tax rate is lower than -0.17 . With a semi-elasticity of approximately -0.17 , a one dollar increase in taxes decreases wages by one dollar.

We also consider a potential endogeneity bias between wages and corporate taxes. As emphasized by Gentry (2007), governments can increase capital taxes just before an anticipated decrease in wages. Finding a valid instrument for the statutory tax rate that satisfies both the property of exogeneity (uncorrelated with the error term) and the property of being partially correlated with the endogenous explanatory variable is challenging. However, one possibility for estimating parameters consistently in the presence of endogeneity is to combine instrumental variables and first differencing (Verbeek 2008; Wooldridge 2009). By first-differencing equation (7), we obtain:

$$\begin{aligned} \Delta \text{Ln}(\text{Wage})_i^t = & + \beta_1 \Delta \text{Ln}(\text{Value-added})_i^t + \beta_2 \Delta \text{Ln}(\text{GDP per capita})_i^t \\ & + \beta_3 \Delta \text{Trade openness}_i^t + \beta_4 \Delta \text{Unemployment rate}_i^t \\ & + \beta_5 \Delta \text{Price wedge}_i^t + \beta_6 \Delta \text{STR}_i^t + \lambda_t + \Delta \epsilon_i^t. \end{aligned} \quad (9)$$

We then estimate equation (9) using two-stage least squares, in which the first-difference of the tax variable, ΔSTR_i^t , is instrumented by the second lag of the statutory tax rate, STR_i^{t-2} (column 3). Such an instrument is permitted in the first-difference model by the absence of second-order autocorrelation of the first-differenced errors. Tests for AR(1) and AR(2) indicate that there is no serial correlation. Thus, STR_i^{t-2} is not correlated with $\Delta \epsilon_i^t$. In an unreported first stage, the coefficient of STR_i^{t-2} is negative and statistically significant at the 1% level (with a magnitude of -0.1123 and standard errors 0.0343). The large Cragg-Donald Wald F statistic suggests that the instrument is valid — that is, it is not weakly correlated to ΔSTR_i^t and it is exogeneous. However, a Durbin-Wu-Hausman test cannot reject the exogeneity of ΔSTR_i^t , suggesting that the OLS estimator is consistent and more efficient than the IV estimator (the variance of the OLS estimator being smaller than the IV one).

5.2. Country characteristics and the incidence of corporate tax rates on wages

Mobility of capital and influence on prices

Table 5 presents several variants of the equation (8) where the influence of four country characteristics are in turn and simultaneously tested. In column 1, we test the assumption that the magnitude of the tax burden shifted from capital to labour would increase with a country's degree of capital openness. In particular, we include an interaction of the statutory tax rate with a measure of capital openness suggested by Chinn and Ito (2008). The interaction term has the expected sign, as the shift of the additional corporate tax burden to wages increases with the level of capital openness, and is statistically significantly different from zero at the 5% level. For a country with an average capital openness (for example, Sweden), a one percentage point increase in corporate taxes decreases wages by 0.17%. This semi-elasticity reaches -0.25 for countries with the highest index (for example, the United States, Germany, Canada or the Netherlands).

In columns (2) to (3)', we test the small-country effect. The shift of the tax burden from capital to labour is expected to decrease with a country's ability to influence the world return to capital and/or the terms of trade. The Lane and Milesi-Ferretti (2007) financial assets variable (which measures the relative size of a country in the world capital market) and the export share variable or the export share in manufacturing variable (which measure the relative size of a country in the world market supply) are interacted with the statutory tax rate respectively in columns (2), (3) and (3)'. These estimated coefficients on the interaction terms are statistically significantly different from zero and have the expected sign because the magnitude of the negative effect of corporate tax rate on wages decreases with the size of an open economy. In a country with an average level of financial assets (for example, Japan or France), a one percentage point rise in corporate taxes decreases wages by 0.02%. A maximum decrease of 0.1% occurs for countries with a relatively low influence over the world capital market (for example, Australia). Regarding now a country's relative influence over the world price of output, a one percentage point increase in the statutory tax rate diminishes wages by 0.09% in a country with average export shares (for example, Italy). This decrease reaches 0.25% for countries with low export shares (for example, Norway). We obtain similar results when an alternative variable, the export share in the manufacturing sector, is interacted with taxes. For a country with an average level of export share in manufacturing (for example, the United Kingdom), the semi-elasticity corresponds to -0.07 and reaches -0.29 for smaller countries (for example, Norway).

In column 4, we examine the effect of corporate taxes on wages by distinguishing countries with a tax-credit system from countries with an exemption system. In so doing, we interact the dummy variable Credit with the statutory tax rate. With the assumption that a residence-based capital tax limits the mobility of capital, because the burden of the tax can hardly be avoided by investing in a foreign country, the elasticity of wages with respect to corporate taxes is expected

TABLE 5
The incidence of corporate tax rates on wages: Mobility of capital and influence on prices

	Openness		Small country effect		Tax system	Simultaneous test of country characteristics	
	Capital openness (1)	World capital market (2)	Tradeables (3)	Tradeables manufacturing (3) ^c		(5)	(6)
Ln value-added	0.8591 ^a (0.0205)	0.8074 ^a (0.0242)	0.8470 ^a (0.0189)	0.8590 ^a (0.0198)	0.8654 ^a (0.0191)	0.8200 ^a (0.0285)	0.8219 ^a (0.0291)
Ln GDP per capita	0.5506 ^a (0.0910)	0.4912 ^a (0.1138)	0.5339 ^a (0.0938)	0.4708 ^a (0.0950)	0.4386 ^a (0.0917)	0.4805 ^a (0.1185)	0.4777 ^a (0.1191)
Trade openness	-0.0015 ^b (0.0006)	-0.0013 ^b (0.0006)	-0.0013 ^b (0.0006)	-0.0011 ^c (0.0006)	-0.0010 ^c (0.0006)	-0.0014 ^b (0.0007)	-0.0014 ^b (0.0007)
Unemployment rate	0.4317 ^b (0.1797)	0.1914 (0.2025)	0.2085 (0.1797)	0.1255 (0.1804)	0.2155 (0.1746)	0.1927 (0.1979)	0.1829 (0.2004)
Price wedge	0.9037 ^a (0.0886)	0.8456 ^a (0.0891)	0.9549 ^a (0.0840)	1.0066 ^a (0.0858)	0.9516 ^a (0.0817)	0.7909 ^a (0.0974)	0.7856 ^a (0.0988)
STR	0.0298 (0.0973)	-0.1138 (0.1029)	-0.2874 ^a (0.0764)	-0.3328 ^a (0.0771)	0.2017 (0.1235)	-0.1330 (0.1236)	-0.0750 (0.2081)
Capital openness	0.0484 ^b (0.0203)					0.0918 ^a (0.0229)	0.0934 ^a (0.0235)
STR × Capital openness	-0.1131 ^b (0.0462)					-0.2038 ^a (0.0575)	-0.2087 ^a (0.0594)
Financial assets		-0.3585 (0.6464)					1.5342 ^c (0.9021)
STR × Financial assets		1.7770 ^c (1.0358)					-2.3843 (1.7947)

	Openness	Small country effect		Tax system	Simultaneous test of country	
		World capital market	Tradeables		characteristics	
	Capital openness (1)	(2)	(3)	Credit vs. exempt (4)	(5)	(6)
Exports						
STR × Exports			−3.0178 ^a (1.0048) 4.3930 ^a (1.3924)			
Export manufacturing					−0.0497 ^a (0.0131) 0.1101 ^a (0.0275)	−0.0475 ^a (0.0146) 0.1043 ^a (0.0322) −0.0564 (0.1628) −4.4314 ^a (1.1766)
STR × Export manufacturing						
STR × dummy tax-credit				−0.4120 ^a (0.1212) −4.1681 ^a (0.9000)		
Constant	−5.2897 ^a (0.8974)	−4.5223 ^a (1.1146)	−4.9044 ^a (0.9257)		−4.4413 ^a (1.1734)	
Observations	272	232	272	273	231	231
R-squared	0.9809	0.9745	0.9814	0.9809	0.9721	0.9721

NOTES: The letters “a,” “b,” and “c” indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included. The dummy variable “credit” is not included on its own because of its perfect correlation with the country fixed effects.

to be higher in tax-exempt systems than in tax-credit systems. Unexpectedly, the interaction term shows the opposite sign and is relatively precisely estimated. One possibility for this result is that a simple tax-credit dummy might capture other country characteristics, which can have an effect on the magnitude of the corporate tax shift from capital to labour. In columns 5 and 6, we simultaneously introduce the country characteristics into the model, as they are not expected to have separate effects. In column 5, we introduce a measure for openness and two measures for the size of a country to capture the ability to influence the world return to capital and the terms of trade. For the ability to influence the terms of trade we select the most direct measure — that is, export share in manufacturing (because the tax incidence is identified at the manufacturing sector level). When tested simultaneously, the level of capital openness and the level of export share in manufacturing continue to play the expected effect on the magnitude of shift. The shift of an additional tax burden to wages increases with the degree of capital openness and decreases with a country's relative influence over the terms of trade. The level of financial assets is not statistically significant anymore. We obtain the same results in column 6, when the interaction term with the dummy tax credit is added. The estimated coefficient of the interaction term between the dummy tax credit and corporate taxes is not statistically significant anymore when the other country characteristics, which might influence the magnitude of the shift, are introduced in the model. In spite of anti-deferral regimes and cross-crediting limitations, this result suggests that capital from tax credit systems is not less diverted by international tax considerations than capital from tax-exempt systems.

Trade unions' strength

In table 6, we test the role played by trade unions' strength on the magnitude of the tax burden shifted to labour. We introduce four measures in turn to the basic model corresponding to equation (8), and we include their interactions with the statutory tax rate: union density, union coverage, bargaining collaboration and bargaining centralization. Union density is the only variable with an estimated coefficient that is statistically significant. This result gives credence to the argument by Fitzenberger et al. (2008) that union density is a pre-bargaining indicator for unions' power and, the best measure of unions' power, as the length of a strike depends on unions' funding. The sign of the interaction term indicates that the magnitude of the shift increases with union density. A one percentage point increase in corporate taxes decreases wages by -0.02% in a country with an average union density (for example, Canada or Germany) and up to -0.23% for countries with the highest union density (for example, Sweden). Interestingly, union density does not show a monotonic positive relationship with the level of wages. In the presence of an increase in corporate taxes, stronger unions are more inclined to a decrease in the wage level. This result is in line with an insurance motive of union representation (Agell and Lommerud 1992; Burda 1995). By narrowing wage differentials among workers, with a redistribution from high- to low-wage workers, unions provide an insurance against the aggregated tax shock

TABLE 6
The incidence of corporate tax rates on wages: Unions' strength

	Density (1)	Coverage (2)	Barg. coordination (3)	Barg. centralization (4)
Ln value-added	0.8786 ^a (0.0204)	0.8686 ^a (0.0208)	0.8448 ^a (0.0201)	0.8549 ^a (0.0191)
Ln GDP per capita	0.4864 ^a (0.1022)	0.6499 ^a (0.0909)	0.4811 ^a (0.0957)	0.5899 ^a (0.0974)
Trade openness	-0.0023 ^a (0.0008)	-0.0020 ^a (0.0008)	-0.0013 ^b (0.0006)	-0.0013 ^b (0.0006)
Unemployment rate	0.3471 ^c (0.2052)	0.7679 ^a (0.1914)	0.3366 ^c (0.1887)	0.4838 ^a (0.1827)
Price wedge	0.7821 ^a (0.1205)	0.7613 ^a (0.1126)	0.8831 ^a (0.0865)	0.9342 ^a (0.0845)
STR	0.9482 ^a (0.3575)	0.5624 (0.5847)	0.0573 (0.1457)	-0.2070 (0.1317)
Ln union density	0.1242 ^a (0.0342)			
STR × Ln union density	-0.2634 ^a (0.0917)			
Ln union coverage		-0.0012 (0.0430)		
STR × Ln union coverage		-0.1289 (0.1381)		
STR × Barg. coordination			-0.0473 (0.0402)	
STR × Barg. centralization				0.0458 (0.0372)
Constant	-5.1456 ^a (0.9718)	-6.3171 ^a (0.8990)	-4.5257 ^a (0.9483)	-5.6041 ^a (0.9549)
Observations	244	229	276	274
R-squared	0.9834	0.9841	0.9793	0.9802

NOTES: The letters "a," "b" and "c" indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included. The variables bargaining coordination and bargaining centralization are not included on their own because of their perfect correlation with country fixed effects.

that reduces the quasi-rent over which firms and unions can bargain. The compression of wages, which increases with unions' density, tends to overcompensate unions' objective of higher wage levels.

In table 7, we examine the interaction term between union density and the statutory tax rate in conjunction with the other country characteristics that can have an effect on the magnitude of the tax burden shifted to labour. The estimated coefficient on the interaction term remains statistically significant when we augment the model by capital openness (column 1) and financial assets (column 2), both variables being interacted with the statutory tax rate. However, the sign of the coefficient changes when we include in column 3 an interaction term between the share in manufacturing and the statutory tax rate. All in all, the capital openness and export share in manufacturing variables have a conditional effect on the relationship between corporate taxes and wages that is not altered across regressions. Those effects remain indeed statistically significant and with

TABLE 7

The incidence of corporate tax rates on wages: Union density, capital mobility and influence on prices

	(1)	(2)	(3)
Ln value-added	0.8750 ^a (0.0217)	0.8233 ^a (0.0280)	0.8020 ^a (0.0289)
Ln GDP per capita	0.5276 ^a (0.1029)	0.5244 ^a (0.1471)	0.4060 ^a (0.1435)
Trade openness	-0.0021 ^b (0.0008)	-0.0021 ^b (0.0009)	-0.0016 ^c (0.0008)
Unemployment rate	0.4851 ^b (0.2135)	0.0184 (0.2616)	-0.0884 (0.2627)
Price wedge	0.8211 ^a (0.1218)	0.7713 ^a (0.1389)	0.9182 ^a (0.1233)
STR	1.1933 ^a (0.3713)	2.2026 ^a (0.7502)	-2.1312 ^b (0.8218)
Ln union density	0.1087 ^a (0.0349)	0.1859 ^a (0.0678)	-0.1625 ^b (0.0748)
STR × Ln union density	-0.2860 ^a (0.0915)	-0.5083 ^a (0.1850)	0.5822 ^a (0.2051)
Capital openness	0.0410 ^c (0.0209)	0.0892 ^a (0.0289)	0.1306 ^a (0.0305)
STR × capital openness	-0.1027 ^b (0.0467)	-0.2099 ^a (0.0702)	-0.3322 ^a (0.0755)
Financial assets		-0.1652 (0.7655)	4.7916 ^a (0.9175)
STR × Financial assets		0.3857 (1.2548)	-10.0990 ^a (1.7701)
Exports manufacturing			-0.1730 ^a (0.0215)
STR × Exports manufacturing			0.3258 ^a (0.0472)
Constant	-5.5568 ^a (0.9794)	-5.6847 ^a (1.3469)	-2.8487 ^b (1.3981)
Observations	244	208	190
R-squared	0.9838	0.9766	0.9812

NOTES: The letters “a,” “b” and “c” indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included.

the expected sign when other country characteristics are included in columns 5 and 6 of table 5 and columns 1 to 3 of table 7.

5.3. Short-run versus long-run corporate tax incidence

The question remains as to what extent the burden estimated would be higher in the long run. It is not unreasonable to expect that the wage-bargaining process following a change in corporate taxes might take time. The magnitude of the semi-elasticities estimated suggests however that the integrality of an increase in corporate tax can be passed on in lower wages in the short run. This impact occurs when the cost for labour equals or is higher than the fiscal receipts generated by the increase in corporate tax.²¹ To shed light about the time horizon over which

21 From our back-of-the-envelope calculations, this result occurs when the estimated coefficient for the statutory tax rate equals or is lower than -0.17.

corporate tax has an incidence on wages, we use a semi-logarithmic functional form in distributed lag models:

$$\begin{aligned} \text{Ln(Wage)}_{it} = & \alpha_i + \beta_1 \text{STR}_{it} + \beta_2 \text{STR}_{it-1} + \beta_3 \text{STR}_{it-2} + \beta_4 \text{Ln(Value-added)}_{it} \\ & + \beta_5 \text{Ln(GDP per capita)}_{it} + \beta_6 \text{Trade openness}_{it} \\ & + \beta_7 \text{Unemployment rate}_{it} + \beta_8 \text{Price Wedge}_{it} + \lambda_t + \epsilon_{it}, \end{aligned} \quad (10)$$

where β_1 is the short-run semi-elasticity between corporate taxes and wages and $(\beta_1 + \beta_2 + \beta_3)$, is the long-run semi-elasticity. In table 8, we first replicate the results of the baseline equation (7), the static model, for comparison purposes (column 1). Then we test whether wages react to changes in statutory tax rates with one lag (column 2) and two lags (column 3). The estimated coefficients of the statutory tax rates are not individually significant in both distributed lag models. They are estimated imprecisely due to their strong correlation, and this multicollinearity makes it difficult to estimate the incidence of corporate taxes at each lag. However, the estimated coefficients are neither jointly significant. In column 2, the estimated long-run semi-elasticity between taxes and wages is statistically significant at the 10% level. But note that the magnitude of the long-run estimated *STR* coefficient, -0.1125 , is not statistically different from the *STR* coefficient estimated with the static model -0.1088 . With this similar magnitude and the fact that STR_{t-1} is individually and jointly statistically insignificant, using the static model is justified. The same can be said with the two lags model in column 3 because STR_{t-1} and STR_{t-2} are not individually nor jointly statistically significant and the long-run coefficient is not statistically significant at conventional levels.

Arulampalam et al. (2012) confirm these results, as they find that the whole shift from capital to labour happens within one period. In the same vein, by adding lagged values of the corporate tax rate variables to the analysis of Hassett and Mathur (2006), Gravelle and Hungerford (2007) find no long-term effects of corporate taxes on wages. Is this quick response of wages to corporate tax rate changes realistic? Within a wage-bargaining framework, the fast transfer of the corporate tax burden depends on the frequency of the negotiations of contracts. According to Layard et al. (2005), wages are negotiated each year in Europe and every third year in the United States and Canada. In the latter countries, these long contracts include “contingent elements” and thus they do not have a fixed expiration date but amendable dates. In practice, contracts are renegotiated more frequently than every third year. For instance, the analysis of von Nordenflycht and Kochan (2003) on labour contract negotiations in the US airline industry indicates that contracts are negotiated every second year in a sample of 39 airlines and 17 unions over the period 1982–2002. Thus, considering that the semi-elasticity estimated in the static model captures the ultimate direct effect of corporate tax on wages is not unreasonable.

Are these results plausible within a framework in which wages are based on labour productivity? The indirect effect of corporate taxes on wages — that is,

TABLE 8
Short-run versus long-run effects

	Static model Baseline equation	Distributed lag model	
	(1)	One lag (2)	Two lags (3)
Ln value-added	0.8487 ^a (0.0196)	0.8534 ^a (0.0203)	0.8619 ^a (0.0220)
Ln GDP per capita	0.5198 ^a (0.0897)	0.5036 ^a (0.0945)	0.4669 ^a (0.0996)
Trade openness	-0.0013 ^b (0.0006)	-0.0013 ^b (0.0006)	-0.0010 (0.0006)
Unemployment rate	0.4244 ^b (0.1727)	0.3649 ^b (0.1836)	0.3074 (0.1918)
Price wedge	0.8673 ^a (0.0818)	0.8823 ^a (0.0858)	0.9208 ^a (0.0895)
<i>STR</i>	-0.1088 ^c (0.0584)	-0.0913 (0.1061)	-0.0717 (0.1075)
<i>STR</i> _{<i>t</i>-1}		-0.0212 (0.1019)	-0.0531 (0.1398)
<i>STR</i> _{<i>t</i>-2}			0.0276 (0.1024)
Constant	-4.8990 ^a (0.8889)	-5.3585 ^a (0.9828)	-5.0407 ^a (1.0316)
Observations	286	278	267
<i>R</i> -squared	0.9786	0.9786	0.9778
Estimated long-run <i>STR</i> coefficient		-0.1125 ^c	-0.0973
Joint significance <i>STR</i> : <i>t</i> , <i>t</i> -1		0.1823	0.4393
Joint significance <i>STR</i> : <i>t</i> , <i>t</i> -1, <i>t</i> -2			0.4439
Joint significance <i>STR</i> : <i>t</i> -1, <i>t</i> -2			0.9304

NOTES: The letters "a," "b" and "c" indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included.

through a change in the capital stock affecting the level of pre-tax profit, might take more time than through the wage-bargaining channel. According to Harberger (2006), the time horizon of the tax incidence via a change in capital stock depends on the size of the corporate tax rate's change. More specifically, the smaller the increase in the corporate tax, the faster the transfer of the burden: "with a tiny tax change, the needed adjustment of the capital stock might turn out to be possible almost instantaneously, and without any extra cost. In such a case we might jump to the long-run equilibrium solution in a single period" (p. 31). In our study, 80% of the tax changes are lower than or equal to five percentage points (with more than one third of these changes corresponding to one percentage point) and fewer than 10% are higher than 10 percentage points. We can infer that most of the indirect effect of corporate taxes on wages should happen within the short run. However, because a few changes are substantially large in magnitude, the indirect effect might last for more than one period. To shed light on a potential different time horizon of the indirect effect, one

possibility is to remove the value-added variable from the distributed lag models. Here again, we estimate an overall effect of the tax incidence that has to be interpreted with caution due to an omitted variable bias. The results presented in table A1 in the appendix suggest that there is further shifting of the tax burden after the first period. The estimated coefficient on the first lag of the statutory tax rate and the estimated long-run statutory tax rate coefficient with two lags are statistically significantly different from zero. This result suggests that the overall effect of a change in the corporate tax rate may take three years to occur fully.

6. Wage adjustments: A discussion

A related question to the analysis of corporate tax incidence on wages is how the wage adjustments are done in practice. Such a discussion is required to reconcile the transmission of the capital income tax into a reduction in wages when nominal wage rigidity is observed in the real world. research on downward nominal wage rigidity (DNWR) can provide some insight. This research indicates that if the existence of DNWR is well established at the individual level, DNWR tends to disappear at the aggregate industry or country level.²² The behaviours of firms could undo the DNWR observed at the individual level and explain this paradox. For instance, Farès and Lemieux (2001) investigate the wage adjustments of Canadian employees to the business cycles and find that the wage adjustment is borne by new entrants who are hired at a lower nominal wage. In the same vein, Babecky et al. (2009) shed light on the options used by firms to adjust their wage bills when they face a negative exogenous shock. With a sample of 11,918 firms in 12 countries of the European Union over the period 2007–2008, their results indicate that encouraging earlier retirement (older workers having on average higher wages than younger workers) and hiring workers at lower wages are options that are frequently used.

Studies analyzing nominal wage rigidity focus only on base wages. But, as suggested by Babecky et al. (2009) firms have multiple options at their disposal to adjust their wage bills other than decreasing the base wages. The wage measures used by the empirical literature on the incidence of corporate tax rates contain seasonal bonuses given that they correspond to a direct pay received by workers. This is the case for the wage data provided by the Bureau of Labor Statistics used in our paper, and this is also the case for the wage data provided by the International Labor Organization (used by Hassett and Mathur (2006)), the Bureau of Economic Analysis (used by Desai et al. (2007)) and the Luxembourg Income Study (used in Felix (2007)), and it should be also the case with the ORBIS database as the variable provided is the costs of employees (used in Arulampalam

22 For example, Card and Hyslop (1997) find evidence of DNWR for individual US workers, but no corresponding evidence when using state data. Regarding the industry level, DNWR is observed by Holden and Wulfsberg (2007). However, the fraction of wage cuts prevented by DNWR decreased from 61% in the 1970s to 16% in the late 1990s in OECD countries.

et al. (2012)). Seasonal bonuses correspond to non-statutory labour costs that can be determined by collective agreements or that can be set at the discretion of the firm (Babecky et al. 2009). The reduction of this more flexible pay component, as compared to base wages, is found to be one of the most common method used by firms to respond to a shock in Babecky et al. (2009).

How are the wage adjustments done in the countries of our sample? As indicated by figure A4 in the appendix, the nominal wage of the 13 OECD countries of our sample experiences a limited number of cuts during the period of investigation (1980–2004). Four cuts can be identified: in Germany in 1998 and in Japan in 1998, 2001 and 2002. In light of the studies discussed above, these declines can be done with a combination of a reduction of bonuses and base wage cuts. The latter is expected to be done mainly by changing the composition of the workforce—that is, a lower nominal wage for new entrants, as suggested by Farès and Lemieux (2001), and the encouragement of early retirements, as suggested by Babecky et al. (2009). In addition to these few downward adjustments of the nominal wages, inflation in a single year can provide some opportunity to reduce the real wage. Table A5 in the appendix shows the annual percentage change of the consumer price index and of the nominal wages for each country of the sample. Nominal wage growth above inflation corresponds to a positive real wage growth. However, inflation above nominal wage growth corresponds to a negative real wage growth. All the countries of the sample have episodes of inflation being higher than the nominal wage growth. This pattern suggests that inflation can provide some opportunity to reduce the real wage during the period of investigation.

7. Conclusion

In this paper, we revisit the extent to which the burden of corporate taxes is shifted to labour using wages and productivity data from the Bureau of Labor Statistics. Our empirical analysis is based on a wage-bargaining framework. Conditional on value-added, our baseline estimates indicate that a one percentage point increase in corporate tax rates reduces wages by 0.1% in the manufacturing sector for 13 OECD countries over the period 1980–2004. Back-of-the-envelope calculations based on this semi-elasticity suggest that a one-dollar increase in taxes decreases wages by 60 cents. The magnitude of this shift is however significantly determined by country characteristics influencing the process of wage determination, such as the degree of mobility of capital, the relative influence of a country over the world price of output and the strength of unions. More precisely, the results indicate that domestic labour's burden increases with the degree of capital openness, with the density of unions, and decreases with the size of an economy in the world capital market and in the world market supply. We also investigate whether the incidence of corporate taxes on wages differs between countries with a corporate income tax that is residence-based and countries with a corporate income tax

that is source-based. We do not find any robust difference in incidence between both types of tax systems.

In addition, the results suggest that in a small open economy with high union density, the cost for domestic labour can exceed the full corporate income tax burden. This strong distribution effect gives credence to the results of Gordon (1986). Economies with these characteristics might be better off taxing immobile labour directly to avoid inefficiencies caused by a corporate tax. In line with Gravelle and Smetters (2006), the results also suggest that an open economy does not necessarily require that labour bears most of the burden of a capital income tax. In large open economies in which an increase in corporate tax rate generates a worldwide decline in the return to capital, or in which an increase in the price level is feasible, or in which the unions' main objective is not the pursuit of an egalitarian wage policy, domestic labour's burden would therefore be lower.

Appendix

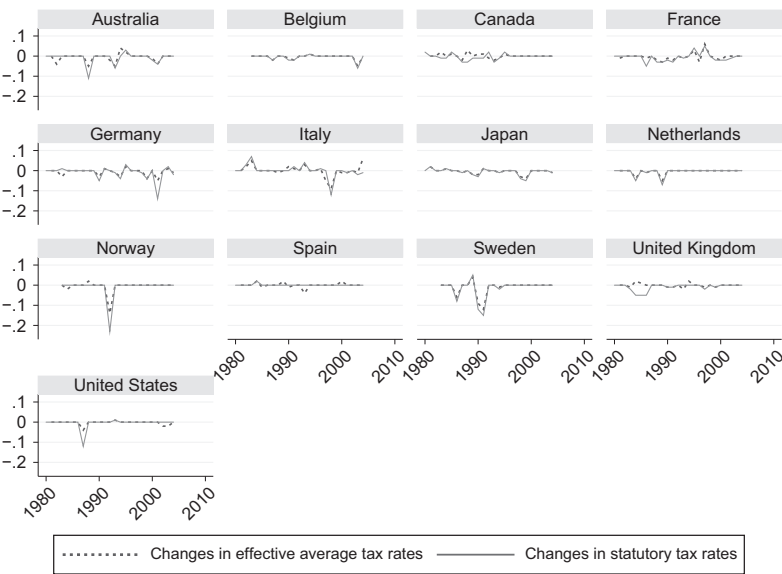


FIGURE A1: Changes in statutory tax rates and average effective tax rates

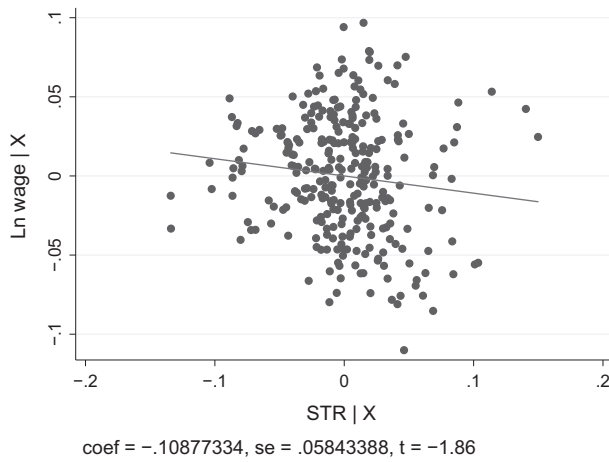


FIGURE A2: Tax incidence on wage: Without outliers

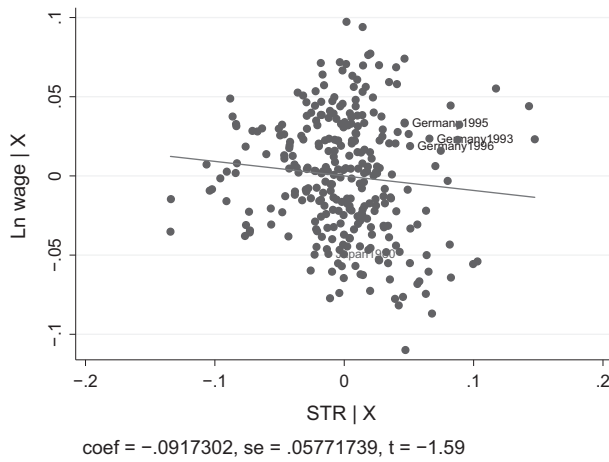


FIGURE A3: Tax incidence on wage: With outliers



FIGURE A4: Nominal wage growth for 13 OECD countries

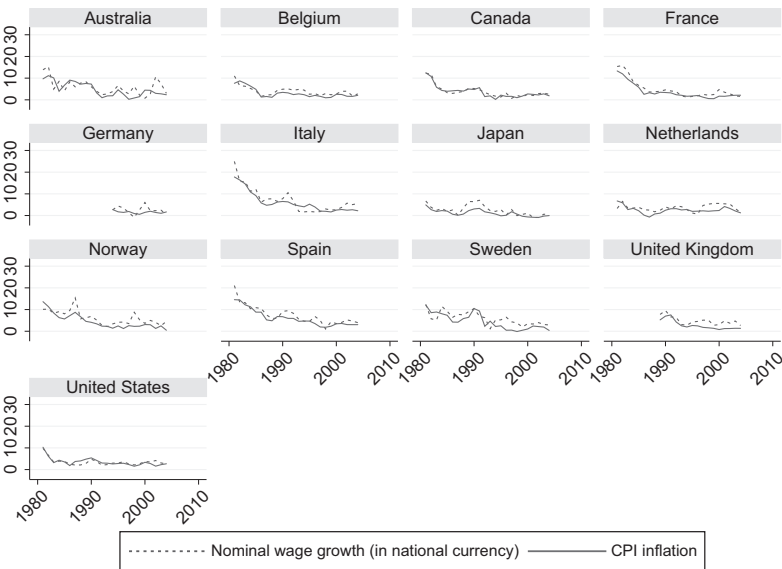


FIGURE A5: Nominal wage growth and CPI inflation for 13 OECD countries

TABLE A1
Short-run versus long-run effects: Overall incidence

	Static model Baseline equation	Distributed lag model	
	(1)	One lag (2)	Two lags (3)
Ln value-added	—	—	—
Ln GDP per capita	0.4745 ^c (0.2647)	0.6778 ^b (0.2746)	0.8251 ^a (0.2772)
Trade openness	−0.0099 ^a (0.0016)	−0.0095 ^a (0.0016)	−0.0089 ^a (0.0016)
Unemployment rate	−0.1493 (0.5083)	0.3514 (0.5340)	0.8071 (0.5346)
Price wedge	2.0056 ^a (0.2288)	2.0533 ^a (0.2361)	2.0022 ^a (0.2377)
<i>STR</i>	−0.4336 ^b (0.1711)	0.0308 (0.3086)	0.1509 (0.2997)
<i>STR</i> _{<i>t</i>−1}		−0.5096 ^c (0.2944)	−0.1340 (0.3906)
<i>STR</i> _{<i>t</i>−2}			−0.4130 (0.2843)
Constant	−0.7843 (2.6095)	−3.2693 (2.8545)	−4.8652 ^c (2.8813)
Observations	286	278	267
R-squared	0.8129	0.8178	0.8264
Estimated long-run <i>STR</i> coefficient		−0.4789 ^a	−0.3961 ^b
Joint significance <i>STR</i> : <i>t</i> , <i>t</i> −1		0.0136	0.8810
Joint significance <i>STR</i> : <i>t</i> , <i>t</i> −1, <i>t</i> −2			0.0515
Joint significance <i>STR</i> : <i>t</i> −1, <i>t</i> −2			0.0620

NOTES: The letters “a,” “b” and “c” indicate a statistical significance level of 1%, 5% and 10%, respectively. Standard errors are in parentheses, and time dummies are included.

References

- Agell, J., and K. E. Lommerud (1992) "Union egalitarianism as income insurance," *Economica* 59(235), 295–310
- Alesina, A., and R. Perotti (1997) "The welfare state and competitiveness," *The American Economic Review* 87(5), 921–39
- Arulampalam, W., M. P. Devereux, and G. Maffini (2012) "The direct incidence of corporate income tax on wages," *European Economic Review* 56, 1038–54
- Auerbach, A. (2006) "Who bears the corporate tax? A review of what we know." In J. Poterba, ed., *Tax Policy and the Economy*, Vol. 20. Cambridge, MA: The MIT Press
- Babecky, J., P. Du Caju, T. Kosma, M. Lawless, J. Messina, and T. Room (2009) "The margins of Labour Cost Adjustment Survey evidence from European firms," The World Bank policy research working paper no. 5160
- Betts, J. R. (1995) "Does school quality matter? Evidence from the National Longitudinal Survey of Youth," *The Review of Economics and Statistics*, 77(2), 231–50
- Bradford, D. (1978) "Factor prices may be constant, but factor returns are not," *Economics Letters*, 1(3), 199–203
- Burda, M. C. (1995) "Unions and wage insurance," CEPR discussion paper no. 1232
- Bureau of Labor Statistics (2006) "International Comparisons of Hourly Compensation Costs in Manufacturing, 2006," database. US Department of Labor
- Calmfors, L., and J. Driffill (1988) "Bargaining structure, corporatism and macroeconomic performance," *Economic Policy* 6, 14–61
- Carbaugh, R. J. (2009) *International Economics*, 12th edition. Masson, OH: South-Western Cengage Learning
- Card, D., and D. Hyslop (1997) "Does inflation grease the wheels of the labor market?" In C. Romer and D. Romer, eds., *Reducing Inflation: Motivation and Strategy*, pp. 711–21. Chicago: University of Chicago Press
- Chen, Y.-C., K. Rogoff, and B. Rossi (2010) "Can exchange rates forecast commodity prices?," *The Quarterly Journal of Economics* 125(3), 1145–94
- Chinn, M. D., and H. Ito (2008) "A new measure of financial openness," *Journal of Comparative Policy Analysis* 10(3), 307–20
- Daveri, F., and G. Tabellini (2000) "Unemployment, growth and taxation in industrialised countries," *Economic Policy* 30, 49–90
- Desai, M., F. Foley, and J. Hines (2007) "Labor and capital shares of the corporate tax burden: International evidence," prepared for the International Tax Policy Forum and Urban-Brookings Tax Policy Center Conference on Who Pays the Corporate Tax in an Open Economy
- Devereux, M., R. Griffith, and A. Klemm (2002) "Corporate income tax reforms and international tax competition," *Economic Policy* 35, 451–95
- Farès, J., and T. Lemieux (2001) "Downward nominal-wage rigidity: A critical assessment and some new evidence for Canada." In A. Crawford, ed., *Price Stability and the Long-Run Target for Monetary Policy*, 3–47, proceedings of the Bank of Canada
- Felix, A. (2007) "Passing the burden: Corporate tax incidence in open economies," Federal Reserve Bank of Kansas City regional research working paper RRWP 07-01
- Fitzenberger, B., K. Kohn, and A. Lembcke (2008) "Union density and varieties of coverage: The anatomy of union wage effects in Germany," CEP discussion paper no. 859
- Gentry, W. (2007) "A review of the evidence on the incidence of the corporate income tax," Office of Tax Analysis paper 101
- Gordon, R. H. (1986) "Taxation of investment and savings in a world economy," *The American Economic Review* 76(5), 1086–102

- Gravelle, J. (2010) "Corporate tax incidence: Review of general equilibrium estimates and analysis," Congressional Budget Office working paper no. 2010-03
- Gravelle, J., and T. Hungerford (2007) "Corporate tax reform: Issues for Congress," Congressional Research Service report for Congress no. RL34229
- Gravelle, J., and K. 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
- Gruber, J. (1997) "The incidence of payroll taxation: Evidence from Chile," *Journal of Labor Economics* 15(3), S72–S101
- Harberger, A. (1962) "The incidence of the corporation income tax," *Journal of Political Economy* 70, 215–40
- (1995) "The ABC's of corporate tax incidence: Insights into the open economy case." In *Tax Policy and Economic Growth*. Washington, DC: American Council for Capital Formation
- (2006) "Corporation tax incidence: Reflections on what is known, unknown and unknowable." In D. John and G. Zodrow, eds., In *Fundamental Tax Reform: Issues, Choices, and Implications*. Cambridge, MA: The MIT Press
- Hassett, K., and A. Mathur (2006) "Taxes and wages," American Enterprise Institute working paper no. 128
- Heston, A., R. Summers, and B. Aten (2006) "Penn World Table Version 6.2," database, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania
- Holden, S., and F. Wulfsberg (2007) "Downward nominal-wage rigidity in the OECD," European Central Bank working paper series, no. 777
- International Labour Office (2009) "*Key Indicators of the Labour Market*," 6th edition. Geneva: International Labour Office
- Keightley, M. P., and M. F. Sherlock (2012) "The corporate income tax system: Overview and options for reform," Congressional Research Service paper no. R42726
- Kotlikoff, L., and L. Summers (1987) "Tax incidence in a life cycle model with variable labor supply," *The Quarterly Journal of Economics* 93(4), 705–18
- Lane, P. R., and G. M. Milesi-Ferretti (2007) "The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities," *Journal of International Economics* 73, 223–50
- Layard, R., S. Nickell, and R. Jackman (2005) *Unemployment, Macroeconomic Performance and the Labour Market*, 2nd edition. Oxford University Press
- Lockwood, B., and A. Manning (1993) "Wage setting and the tax system," *Journal of Public Economics* 52, 1–29
- Nickell, W. (2006) "The CEP-OECD Institutions Data Set (1960–2004)," CEP discussion paper no. 759
- Ochel, W. (2001) "Collective bargaining coverage in the OECD from the 1960s to the 1990s," *CESifo Forum, Winter*, 62–65
- OECD (2004) *Employment Outlook*. Paris: OECD
- Randolph, W. (2006) "International burdens of the corporate income tax," Congressional Budget Office working paper no. 09
- Sabirianova Peter, K., S. Buttrick, and D. Duncan (2009) "Global reform of personal income taxation, 1981–2005: Evidence from 189 countries," IZA discussion paper no. 4228
- Summers, L., J. Gruber, and R. Vergara (1993) "Taxation and the structure of labor markets: The case of corporatism," *The Quarterly Journal of Economics* 58, 385–411
- Verbeek, M. (2008) *A Guide Modern Econometrics*, 3rd edition. John Wiley & Sons Ltd.
- von Nordenflycht, A., and T. Kochan (2003) "Labor contract negotiations in the US airline industry," *Monthly Labor Review*, July, 18–28

- Wooldridge, J. M. (2009) *Introductory Econometrics A Modern Approach*, 4th edition.
Masson, OH: South-Western Cengage Learning
- Wulfsberg, F. (1997) "An application of wage bargaining models to Norwegian panel data," *Oxford Economic Papers* 49(3), 319–40