ISSN 1725-7557

European Commission

TAXATION PAPERS

WORKING PAPER N.45 - 2014

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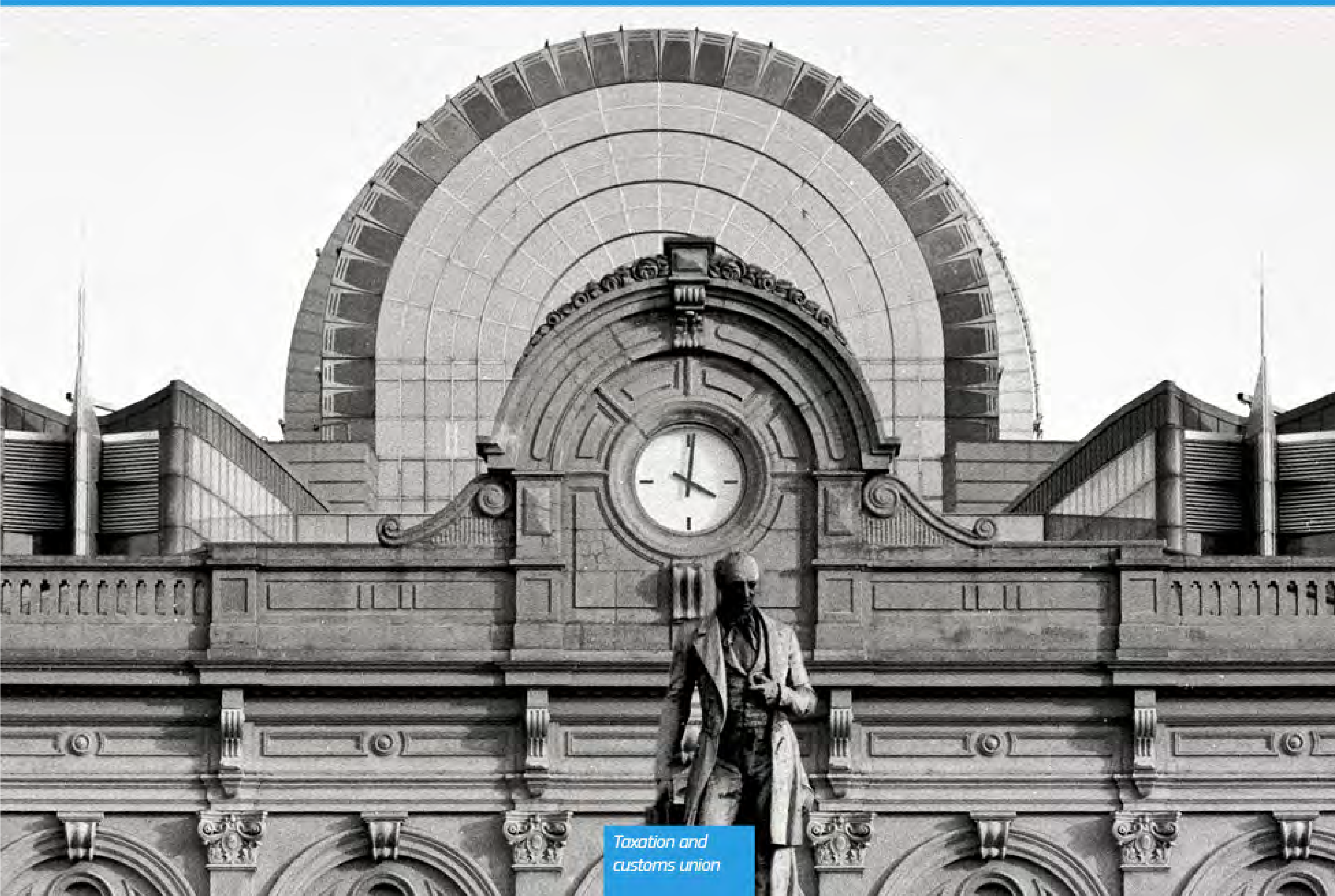

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Luxembourg: Office for Official Publications of the European Communities, 2014

DOI 10.2778/35372
ISBN 978-92-79-38371-7

Printed in Belgium

PRINTED ON WHITE CHLORINE-FREE PAPER

Effective Corporate Taxation, Tax Incidence and Tax Reforms: Evidence from OECD Countries

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This version: 20 May 2014.

Abstract: The present study provides estimates of the Effective Marginal Tax Rates (EMTRs) for a sample of 17 OECD countries and 11 manufacturing sectors in a single framework encompassing capital, labour and energy taxes. Our cross-country/cross-sector approach allows us comparing the incentives provided by the tax systems and gauging the effects of tax changes taking explicitly into account the possible substitution between factors as well as their tax incidence. Our results suggest that the OECD tax systems provide different incentives for manufacturing activity across countries and that tax systems are relatively neutral with respect to the sectoral composition of manufacturing activities. The impact of potential tax increases on firms´ activity is found to be most attenuated when shifted towards consumers and/or employees rather than energy consumption and/or capital investors. These results are robust to alternative hypotheses regarding the tax incidence parameters, elasticity of substitution between factors and mark-up on final prices. In addition, policy strategies favouring tax increases on energy consumption and lowering taxes on labour can substantially reduce the EMTRs and thus yield substantial efficiency gains for firms. These reforms should in some instances be ambitious enough to produce desired effects on firms' EMTRs, however.

Keywords: Taxation, Tax incidence, Effective Taxation
JEL-classification: H20, H22, H24, H25.

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1. Introduction

Since the seminal works of Jorgenson (1963) and Hall and Jorgenson (1967), economists have been interested in the effect of corporate income taxation on the cost of capital. This approach is based on detailed information regarding the tax treatment of capital investment and considers new investment projects with a marginal return on the last unit invested just equal to the marginal cost of the project, the later including the effect of tax provisions. Such work has been extended to cover various types of corporate and non-corporate taxpayers, sources of financing and assets (see e.g. Jorgenson and Yun, 1991 and Jorgenson, 1992). This has led in turn to the development of indicators such as the Effective Marginal Tax Rates (EMTR) in order to capture the tax burden on marginal investment projects by comparing the pre-tax and post-tax cost of capital of such projects (Auerbach, 1979; King and Fullerton, 1984).[2] Effective corporate tax rates are now available from various sources on a periodic basis and are used as measure of the incentives of corporate tax systems on economic activity (see e.g. ZEW, 2012). A large body of empirical studies has also looked at the effect of effective corporate tax rates on the economic behaviour of companies, including their location, investment choices and profit-shifting strategies,[3] while other papers have used these rates to address questions of tax competition between jurisdictions.[4]

Despite their usefulness to measure the economic incentives exerted by corporate tax provisions in a precise way, these approaches are nevertheless limited to the analysis of the effects of taxation on capital investment alone. In reality, firms use multiple production factors and thus face a much larger set of taxes ranging from taxes on their labour employed (social security contributions, payroll taxes, etc.), environmental taxes (e.g. taxes on extraction, on energy use and on Greenhouse gases emissions), VAT (to the extent that the firm cannot deduct the input VAT), property taxes, or (mainly local or regional) taxes on their turnover or their production.[5] In this paper, we compute multi-factor effective marginal tax rates for corporations using a multi-factor approach applying the model-based aggregation

[2] This strand of the literature on effective taxation is also called forward-looking as opposed to backward-looking approaches that look at ex-post data on actual taxes paid. See Nicodeme (2001, 2007) for a review. In addition, the concept of Effective Average Tax Rates (EATR) was developed by Devereux and Griffith (1999) and summarises the distribution of tax rates for investment projects over a range of profitability.

[3] See e.g. Huizinga et al. (2008), Barrios et al. (2012), Feld et al. (2013).

[4] See e.g. Devereux et al. (2012)

[5] For instance, Desai, Foley and Hines (2004) find that the high degree of correlation between corporate income tax rates and other tax rates may have mixed their respective effects whereas the alternative taxes are much larger than corporate income taxes and their effects important, not least because they are often not subject to any international relief in bilateral tax treaties.

proposed by McKenzie et al. (1997) to a sample of OECD countries and manufacturing sectors of activity.[6] Such a measure considers the additional taxes that need to be paid when the use of any input factor, including capital, rises. This allows us conducting cross-country and cross-sector comparisons of the effect of a tax policy changes altering the relative cost of production factors.

We derive a synthetic measure of effective marginal taxation on firms´ activities by using detailed information on the tax codes aggregated at sector level using weights based on sector-specific intensity of factor use. To our knowledge, this is the first study of this type providing a synthetic measure of the effective marginal tax level on a cross-country/cross-sector basis for those three production inputs. Such an endeavor is made possible thanks to the availability of detailed estimates of the EMTR by factor of production. For labour, we use the OECD "taxing wage" model that allows us taking into account the progressivity of tax systems, including the influence of the social contributions paid by both employers and employees. For each wage level, we can simulate the net tax paid by both employers and employees and combine these figures with detailed data from the EUROSTAT Labour Force Surveys to calculate weighted averages for the EMTR on labour considering the differences in wages due to education levels, firm sizes, gender and sectors of activity. For capital, we use the estimates provided by the Centre for European Economic Research (ZEW) based on detailed corporate tax codes for three assets classes, namely Machinery, Buildings and Intangibles. We then construct weighted average measures of the EMTR on capital based on sector-specific investment level in these assets. Finally, for energy, we construct weighted average estimates of the EMTR based on detailed energy effective tax for each fuel and energy type, drawing from the IEA/OECD database. Here again, sector and country-specific weighted average tax levels are calculated taking due account of the intensity of energy uses by sector.

Our all-in approach provides a relatively simple framework for analysing the impact of tax policy changes using comparative static analysis.. More specifically, a recent focus of tax policy, notably in the European Union, is the recommendation made to the Member States to shift taxes away from personal and corporate income towards taxes that are less detrimental to growth, among which environmental taxes which, following Porter (1995) could bring both

[6] We do not consider the case of unincorporated businesses.

environmental and economic efficiency gains.[7] We can measure the impact of such shifts and their effects on the multi-factor marginal effective tax rates faced by businesses.

Our results show that the OECD tax systems provide very different incentives for manufacturing activity across countries and that tax systems are relatively neutral with respect to the sectoral composition within manufacturing activities. The level of total effective marginal taxation is also found to be relatively neutral to the hypothesis made on the degree of substitution between production factors. The impact of potential tax increases on firms´ activity is also found to be most attenuated when shifted towards consumers and/or employees rather than energy consumption and/or capital investors. We perform tax policy changes simulations consisting in shifting taxation away from labour towards energy taxation and show how the tax incidence of production factors and the elasticity of substitution between production factors can prove significant to determine the efficiency gain represented by such tax shifting strategies. Our results suggest that tax-shifting policies would not penalize specific sectors of activity in a significant way and could yield significant efficiency gain (through reduced marginal cost of production) providing these reforms are ambitious enough.

The remainder of the paper is organized as follows. Section 2 provides data sources and details on the calculation of the effective tax indicator. Section 3 describes the methodology used and modeling approach. Section 4 describes the main results and provides simulations of the impact of tax shifting on production cost.

2. Calculating the effective tax level by country and sector of activity

The usual approach for calculating the marginal tax rate on production factors is to consider a marginal increase in the use of production factors. In practice, this requires having detailed information on the tax systems. Our paper follows in spirit the total effective marginal tax rate derived by Mc Kenzie et al. (1997) for the Canadian provinces and a number of production sectors. Our analysis thus takes advantage of studies and databases developed since their paper was first published. We also introduce a number of innovative aspects regarding the role played by tax incidence and factor substitution that can prove important

[7] See the recommendations made in the context of the European Semester and contained in the Annual Growth Survey (European Commission, 2013). This ranking of taxes is derived from several academic works, among which Johansson et al. (2008).

when interpreting the EMTR, especially when using them to gauge the impact of tax policy reforms.

Let us consider labour taxation first. Existing studies analysing the effect of labour tax on the costs of production usually consider the marginal tax burden for an average worker. However, labour taxation is highly complex given the role played by individual characteristics to account for e.g. elements such as marital status, number of dependents, benefits entitlements, etc., which all determines the marginal tax burden when labour income increases by a given amount. Our measure of the total EMTR includes labour marginal taxation paid directly by firms (payroll taxes, mostly in the form of social security contributions) and by workers (wage taxes, including labour income taxes, social security contributions and social benefits) for different levels of labour income. This information is obtained from the OECD "Tax Analyser" model. Our measure of capital taxation is also truly "marginal" to the extent that this paper, like McKenzie et al. (1997), adopts the King and Fullerton (1984) methodology and accounts for the existence of asset-specific tax treatment such as their mode of financing and asset-specific amortization rules. Finally, we extend our measurement of the total effective marginal tax to energy inputs. In this case, however, we only avail of average measures of the effective tax burden. We therefore assume a one-to-one relationship between input use and its extra marginal tax cost like McKenzie et al. (1997). One must note that the measure of the EMTR for the three inputs is made comparable considering in each case the impact of a one-euro increase in the use of a specific input. In the case of capital, we consider a hypothetical one-euro incremental investment undertaken by a given firm considering a post-tax real rate of return required by its shareholders and using the tax code to compute the implied required real pre-tax rate of return. For labour, we consider the marginal increment of earnings that is taken away by the tax system following an increase in labour income by one euro, accounting also with potential interactions with the benefit systems, i.e. foregone benefits or loss of benefits entitlement due to wage increments. For energy and CO2 emissions, the effective taxation is calculated based on a one-euro equivalent input increase following the input-output basis mentioned earlier.[8]

The influence of each production factor on the total effective marginal taxation is captured by the factor-specific weights, which are taken from the OECD STAN database. For

[8] Note that, in all three cases, we therefore assume that the firm can vary their use without considering the possible existence of discontinuity and extensive margin in factor supply. This means in particular that we assume that the absence or shortage of specific production factors (e.g. skilled labour or specific capital assets) is fully reflected in the factors´ pricing and directly influences the tax incidence parameters βi and μ.

capital, these weights are specific to each types of investment, i.e. building, machinery and stock. For labour, the weights depend on the wage distribution within each sector/country, taking into account the categories of workers differentiated by level of education, gender and size of the employing firm. Since each sector makes different use of different type of labour, in particular in terms of its skill content, we thus further differentiate sectors depending on their specific employment characteristics. For energy/CO2, the weights depend on the quantity of fossil fuels and the levy applied to different energy sources, which ultimately reflect cross-sector technological differences. In the remainder of this section, we provide more details on the calculation of each sector-specific effective marginal tax rate.

2.1. Capital

For the capital component, the EMTR is derived directly from the King and Fullerton (1984) methodology and is be expressed as[9]:

$$t_k = \frac{p-s}{p} \qquad (1)$$

Where p is the real pre-tax rate of return that is necessary to generate a zero post-tax economic rent (that is the cost of capital is the initial investment) and s is the real post-tax rate of return to the shareholder.

The EMTR therefore incorporates a wide range of elements going beyond the statutory corporate taxes, such as elements of the tax base, the mode of financing of the investment (debt, retained earnings or new equity), amortization rules or the level of inflation. In presence of taxes, the return to investment is altered and optimality requires the equality of return of different investment types *at the margin*. The main source to calculate the EMTR on capital is the ZEW database on corporate taxation including detailed country-level on information on tax allowances for capital taxation (ZEW, 2013). The ZEW dataset provides estimates of the effective marginal tax rate (EMTR) for all EU countries, Japan and the US (California) split by types of assets and sources of financing for the all years between 1998 and 2012. The three assets categories considered are industrial buildings, intangibles and machinery.[10] In order to calculate an average EMTR by country/industry pair, we need the share of each type of asset purchased by each industry. For this purpose, we use the

[9] See e.g. http://ec.europa.eu/taxation_customs/resources/documents/annexes_en.pdf

[10] The ZEW database also provides estimates of the EMTR financial assets and inventories. These other investment categories are not considered here due to insufficient comparable data. Also ZEW provides EMTR by modes of financing (i.e. debt, equity, retained earnings) which are not considered here for sake of brevity.

EUROSTAT structural Business Statistics for the period 2008-2011.[11] Data on investment in intangibles are taken from the Eurostat Structural Business Statistics for 2009 covering all EU countries by NACE 2-digit sectors. The information contains gross investment in concessions, patents, licences and trademarks and similar rights, investment in purchased software, investment in software produced by the enterprise and payments to subcontractors.[12]

Table (1) provides the (asset-weighted average) values of the EMTR for capital, where the share of each asset in total investment determines the weights.[13] The country with the highest EMTR on capital is - by far - Japan, with an average EMTR at around 40% for all sectors. Interestingly, the US is the country with the second highest EMTR on capital with an average rate of 36.1%. In both countries, the cross-sector variation in EMTR on capital is well below the values observed for other countries as indicated by the standard deviation of the EMTRs. The countries with the lowest EMTRs are Belgium (1.5%), the Czech Republic (7.4%) and Ireland (8.5%). The first two display however a wide variation in their EMTR on capital across sectors of activity due to differences in the types of assets used. For instance, the sectors of Chemical and Petrochemical, Machinery and textile and leather industries display a negative Effective Marginal Tax Rate on capital in Belgium.

2.2. Labour

For labour taxation, we also adopt a *marginal* approach that calculates the additional taxes and social security contributions paid by an average worker when earning an extra euro. A recurrent debate is whether these taxes whose legal incidence is on the employee or the employer have their economic incidence actually shared between both sides via notably an adjustment in wages. In contrast to previous research - which has so far focused on payroll taxes paid by employers and has hence made simplifying assumptions about the actual incidence (see for instance McKenzie et al. 1998 and Vermaeten et al. 1994) - this paper

[11] The share of investment in Machinery displays the highest average values (62.9%) followed by investment in intangibles (20%) and investment in buildings (17%). Investment in machinery is particularly high in Mining and Quarrying (71.3% on average), Paper, pulp & print (71%) and Non-metallic minerals (68.2%) and the Transport equipment industries (66.1%). Investment in intangibles is particularly high in Machinery (32.2%), Chemicals and Petrochemicals (28.6%), Transport Equipment (22.8%) and Textile & Leather (22.3%). Building investment on the other hand are relatively more important for Wood & wood products (21.9%), Non-ferrous metals (19.9%), Mining & quarrying (19.4%) and Other manufacturing industries (19.3%). Despite these average figures, the data shows a great heterogeneity in country/sector shares. Note that the recession experimented by a number of EU countries might introduce some abnormal variations in the share spent in each asset type.

[12] For Japan and the US we did not avail of comparable data such that the average of a selected sample of EU countries deemed to be close technologically from these two countries. These countries are Belgium, Germany, France, the Netherlands, Italy and the UK.

[13] Table A5 in Appendix provides the weights used for total capital investment as percentage of total production cost.

provides measures of labour EMTR based on a net approach (i.e. additional taxes net out of additional social benefits and tax rebates) including both taxes paid by employers (payroll taxes) and employees (wage taxes) and netting out the wage increase from social benefit variations, the latter being especially relevant for economies with generous benefit systems such as (most) OECD countries. We are thus also able to consider the total tax wedge on labour and the possibility for employers to partly absorb part of the tax increases that is legally paid by employees, e.g. though higher wages. We assume that the overall tax incidence on labour is the combination of the tax incidence affecting payroll taxes given by β_l^{er} and the tax incidence affecting the wage taxes paid by workers β_l^{ee}.

Assuming perfect competition in labour markets, the gross wage (i.e. including the effect of taxes) is given by:

$$w^g = p^f MP_l \tag{2}$$

Where w^g is the gross wage. We also consider that the gross wage is determined *ad valorem* such that:

$$\left(1 - t_l^{ee} - t_l^{er}\right) w^g = w \tag{3}$$

Where *w* is the net wage and t_l^{ee} and t_l^{er} are respectively the labour taxes paid by the employee and the employer in percentage of the gross wage. We can then use equations (6) and (7) to calculate the difference between the gross and the net wage in proportion of the net wage, i.e. the tax wedge, as a function of the tax incidence parameters and the tax rates such that:

$$\frac{w^g - w}{w} = t_l^{ee}\beta_l^{ee} + t_l^{er}\beta_l^{er} \tag{4}$$

By considering the possibility that the labour tax is partly shifted from workers to employers, we assume that labour supply might be imperfectly elastic. Since employees´ labour tax might be shifted onto firms we need to consider the progressivity of the tax systems and netting out taxes (including personal income taxes, social contributions and other payroll taxes) of benefits, which are directly or indirectly linked to the levels of labour income. This is done by considering the full details of the tax and benefit codes, including social contribution and compulsory health insurance, pensions and unemployment insurance. For this purpose, we use the *OECD Taxing Wages model* that provides labour EMTR for each level of earnings (expressed in percentage of the country average earning), i.e. the additional tax paid for an additional euro increase in labour earnings. The OECD Taxing Wages model defines the EMTR as the proportion of earnings that is *"taxed away by the combined operation of taxes, social security contributions (SSCs), and any withdrawal of earnings related social benefits"*.[14] Given that the EMTR is a *marginal* measure, it is convenient to use hourly wages in order to determine the level of EMTR corresponding to each sector of activity reflecting both the sector-specific average wage and labour composition. The weights used to calculate the EMTR by sector therefore reflect the hourly wages values by sector and country as provided by the US Bureau of Labour Statistics for a number of OECD and emerging economies according to the ISIC classification.[15]

Beyond sector and country-differences in wages, the existing empirical literature has provided ample evidence on wages differences being determined by labour's and firms' characteristics such as the proportion of skilled workers, gender, etc. (see e.g. Willis, 1985 for a review). In order to consider these differences, we use a recent study by the OECD estimating Mincerian wage equation for a large sample of OECD countries where these characteristics are covered (see Strauss and de la Maisonneuve, 2009). In particular, we use country-specific estimates of the determinants of wage levels for four variables: gender, education attainment, plant-size and the interaction between higher education and gender.[16] In order to account for these individual and firm-specific determinants of wages differentials we re-calculated the average of sector-specific wages using as weights the proportions of women employed, including women with higher education degree, the proportion of employment in large firms[17] and the proportion of employees with higher education degree using detailed data of the *Eurostat Labour Force Survey* (ELFS).[18] To do so, we use country-level data from

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[14] See OECD (2011). We have obtained estimates of the EMTR for levels of wages ranging from 30% to 200% of the average wage, using incremental increases of 5pp successively. We have then allocated the corresponding EMTR to each hourly average wage of each sector/country pair, using manufacturing sectors wage statistics from the U.S. Bureau of Labour Statistics. The EMTR on labour paid directly by employers are also obtained using the OECD Taxing wage model for various levels of effective average taxation (67%, 100% and 167% of average wage). We use a weighted average of the employers´ tax rates on labour corresponding to the different relative wage levels by country/industry.

[15] The database is available at: http://www.bls.gov/data/#international. Missing values were filled in using linear interpolation based on countries´ general economy hourly labour cost index. Table A1 in Appendix provides a description of the average hourly labour cost by sector and country for the period considered here. As can be seen, the standard deviations (last column of Table A1) are broadly comparable across sectors but vary widely across countries, ranging from 10% in Denmark to 28% in Hungary.

[16] The coefficients estimated by Strauss and de la Maisonneuve (2009) are reported in Table A2. Interestingly, these estimate account for the interaction between educational levels and gender and show that in many countries women with a higher education degree still earn less than the average.

[17] Large firms were defined as those with more than 50 employees.

[18] Because the ELFS does not cover Japan or the US, we use average values based on EU countries with the closest characteristics by taking average values belonging to the same quartile as Japan and the US respectively.

the *Barro and Lee database on education attainment* (Barro and Lee, 2010), the *OECD STAN database* for the firm size and the *OECD Labour Force Survey* for the share of women in total employment. These proportions were calculated for the different sectors. The EMTR on labour paid by employers and employees is thus calculated depending on the level of sector-specific hourly wage vs. the average, taking into account individual and firm-level characteristics and sector-specific employment composition. For each country, we calculate the EMTR on labour as a weighted average of the EMTR corresponding to each category of worker, taking as benchmark the average hourly wages values at sector level as indicated below:

$$t_l = \sum_h a_h \, . \, t_l^h \qquad (5)$$

with h indexing individuals according to their characteristics and the weight a_h correspond to the proportion of individuals with characteristics h (i.e. women, highly educated, women with higher education, workers of large firms and the rest of individuals, i.e., male with no higher education degree working in small firms). The EMTR calculated using the OECD Taxing Wages simulated taxes is then allocated to each of these groups depending on the level of relative sectoral wage specific to each category h, which are in turn determined by adjusting the wages levels by considering the Mincerian estimations provided by Strauss and de la Maisonneuve (2009). Tables (2) and (3) show this effective marginal tax rate for employers and employees respectively.[19]

2.3. Energy

The approach for energy/CO2 taxes is slightly different from the one considered for capital and labour. Here, we assume a direct relationship between the level of input used and the level of output. In this case, the *average* and the *marginal* tax rate are equal since the return on factor used follows linearly the level of input used. In order to build our measure of EMTR on energy, we use the *Energy Prices & Taxes Quarterly Dataset* published by the International Energy Agency (IEA, 2012a). This database contains the final prices as well as the net prices (taxes excluded) for 14 primary energy inputs.[20]

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[19] Note in Table (2) the interesting case of Denmark that has no social security contributions on employers.

[20] These inputs are High sulphur fuel oil, Low sulphur fuel oil, Light fuel oil, Automotive diesel, Premium leaded gasoline, Regular leaded gasoline, Premium unleaded 95 RON, Premium unleaded 98 RON, Regular unleaded gasoline, Liquefied petroleum gas, Natural gas, Steam coal, Coking coal and Electricity.

As a general rule, these end-use prices: (i) include transport costs to the consumer; (ii) are prices actually paid (i.e. net of rebates); (iii) include taxes which have to be paid by the consumer as part of the transaction and which are not refundable. This excludes value added tax (VAT) paid in many European countries by industry (including electric power stations) and commercial end-users for all goods and services (including energy).[21] Similarly, net prices only includes (i) and (ii), leaving out the whole variety of excise duties applied to each energy product (excise taxes and special taxes as well) which are grouped to form our energy taxes variable.[22]

This database provides also information by sectors (industry, households and electricity) and further disaggregation for the manufacturing industry. By combining these indicators, we are able to obtain the total tax applied to each energy source. Importantly, the IEA database provides tax rates using homogeneous reference units across energy inputs – the Tonnes of Oil Equivalent (toe) - over a relatively long time period (as from 1978) for a representative panel of EU countries and the Rest of the World (including Japan and the US). We consider a very large range of energy sources in each country to build a measure of the EMTR on energy along two dimensions: in terms of energy content and of carbon emissions.[23] IEA (2012b) contains a very detailed energy balance for a wide number of energy sources in which 93 categories are distinguished. We focus on final consumption of energy by the manufacturing sectors (i.e. from codes 51 to 93 of the IEA classification). For data on CO2 emissions, we use the Carbon Emissions Factors of each energy source to transform energy use expressed in terms of "energy content" into corresponding CO2 emissions reported in Table A3 in Appendix. We follow the approach by the OECD (2013) that computes weighted average excise duties applied to each energy source (although we consider a more detailed classification of energy use relying on the extended energy balance published by the IEA, 2012a). Final (i.e. tax inclusive) and net prices are used to determine the tax rates applying to each primary energy input. We then transform the total taxes applied to each primary input into the total tax applied to each energy source. One should note that in some cases, energy sources can be affected by more than one primary energy inputs. From the IEA (2012b) data, we consider End-Use Energy Prices for 14 primary energy products and

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[21] In these cases, (input) VAT is generally refunded to the (VAT registered) customer. Therefore, it is not included in the prices and taxes columns in the tables. This also applies to automotive diesel for the EU countries.

[22] A detailed description of taxes applied to energy products in each country goes beyond the objectives of this paper. In this regard, IEA (2012b) contains country specific notes for the interested readers.

[23] See Table A3 for a full description of energy sources included.

related end-user taxes by calculating the difference between the final price and the net of tax price and aggregating these for each energy source included in Table A4 based on the reported consumption by sector.[24] In general, the matching of energy sources is straightforward, with only a few exceptions that could be assigned manually.[25] In these cases, the average price of related products is considered instead.[26] The EMTR on energy products can be calculated for each country and sector as indicated below:

$$t_e = \sum_s t_e^s \frac{E_s}{\sum_s E_s} \qquad (6)$$

where s indexes the energy sources and E_s is expressed in physical units (i.e. tons of CO2 or TJ). [27]

Tables (4) shows sector and country average values of the energy effective average tax rate for the period 2001-2010. The sectors "Wood and wood products" (12.9%), "Non metallic minerals" (12.5%), "Non-specified industries" (12.4%), "Food and Tobacco" (12.3%) and "Textile and leather" (12.6%) have the highest EMTRs. Denmark shows the highest EMTR at 28.4%, followed by Italy (20.9%) and the UK (17.5%), while Czech Republic, Hungary and the U.S. are the lowest (under 3%).

[24] The energy products considered are: (A) High sulphur fuel oil (B) Low sulphur fuel oil (C) Light fuel oil (D) Automotive diesel (E) Premium leaded gasoline (F) Regular leaded gasoline (G) Premium unleaded 95 RON (H) Premium unleaded 98 RON (I) Regular unleaded gasoline (J) Liquefied petroleum gas (K) Natural gas (L) Steam coal (M) Coking coal (N), and Electricity.

[25] For instance, "Motor gasoline" could be matched using different prices (leaded vs. unleaded gasoline)

[26] See table A4 for a detailed description of the matching process.

[27] Note that the coverage of our measure of EMTR on energy is limited for three reasons. First, we assume that end-users prices apply equally to all energy purchasers within a given sector of activity, while in reality companies are able to negotiate specific conditions for different energy inputs. This likely biases the EMTR upward. More detailed information is however not available. Second, we do not have information for own-energy production that might be taxed differently from end-user energy purchase. Finally, we do not consider the case of ETS permits for European countries. In practice this should have only a limited impact on our measure of the EMTR as this system only covers CO2 emissions from power generators and energy-intensive industrial sectors i.e., namely, Iron & Steel, Chemicals, Non-ferrous metals, Non-metallic minerals, Mining & Quarrying, Paper, pulp & print. The tax implications of the ETS are far from clear, however. Most EU countries treat ETS allowances as commodity and thus as intermediate consumption with immediate or time-of-use deduction. Other participating countries treat ETS as intangible asset and allow firms to depreciate them over their expected lifetime. For the period covered in the study, the ETS worked mainly as grandfathered allowances system, whose effects are smaller from a tax perspective to an intermediate product since such allocation is made on yearly basis without allowing time depreciation as for a classical physical investment, see in particular Copenhagen Economics (2010). In addition, the economic crisis depressed emissions substantially and thus the demand for allowances, leading to a large and growing surplus of unused allowances and credits.

3. Modelling approach and methodology

3.2 Modelling the EMTR

In order to aggregate the three EMTR calculated on labour, capital and energy we follow McKenzie et al. (1997) and extend their approach to consider monopolistic pricing in the final product market whereby each supplier can impose a mark-up, represented by the term μ, on its own final price that reflects its market power. Following standard price setting, McKenzie et al. (1997) show that a dual optimisation problems yields the total marginal cost of production *T* which can be expressed as a function of each factor's marginal cost and of the final product mark-up such that:

$$T = \frac{MC\left(q^{'};V^{'}\right)}{MC(q^{'};\mathrm{V}^{0})\left(1+\mu\right)} - 1 \qquad (7)$$

Where *MC* is the marginal cost function, *q'* is the level of output, *V* the vector of input prices evaluated at net (V^0) and gross value (V'), the later including the effect of the various taxes on the input prices. Such an approach thus requires the specification of a production function and of its related hypotheses regarding the degree of substitution between production factors as well as the characterization of the supply and conditions in the inputs markets (i.e. supply and demand elasticity) that determine the extent to which the effect of a tax change are passed through changes in user costs.

In this paper we, as Mc Kenzie et al. (1997), consider a standard CES production function, the nominal value of the final production is:

$$q = H\left[\sum_i \frac{a_i}{f_i} x_i^0\right]^{\frac{1}{\rho}} \qquad (8)$$

where x_i is the quantity of input *i* employed, *a*, *f* and ρ are production function parameters with the elasticity of substitution between inputs being equal to $\sigma = 1/(\rho\text{-}1)$ and $q{=}p_f.q^r$ where p_f is the final price of the output being produced and q^r is the real value of output. The value of p_f is defined in a standard way in monopolistic market such that the price is the marginal cost augmented by the mark-up:

$$p_f = (1+\mu).MC\left(q^{'};V^{'}\right)$$

With the CES production function, the gross of tax marginal cost function arising from the production function is:

$$MC(q^{'};V^{'}) = H^{-1}\left[\sum_i a_i^{\frac{-b}{\rho}}(f_i V_i^{'})\right]^{\frac{1}{b}} \quad (9)$$

with $V_i^{'} = V_i^0(1+t_i\beta_i)$, v_i being the unit price of input i , $b=\rho/(\rho-1)$ and $\beta_i = \left[\frac{\eta_i^S}{\eta_i^S + \eta_i^D}\right]$, where η_i^S and η_i^D are the elasticity of supply and demand characterising the market for input *i*. In other words, the gross value of the unit price is the net value plus the incidence of the taxation of the input that falls on the producer.

Using (7) and (9) one can calculate the EMTR specific to the CES production (8) such that:

$$T = \frac{1}{1+\mu}\left[\sum_i A_i(1+t_i\beta_i)^b\right]^{\frac{1}{b}} - 1 \quad (10)$$

Where the factor share of input *i* is given by $A_i = \frac{a_i^{\frac{-b}{\rho}}(v_i^0 f_i)^b}{\sum_i a_i^{\frac{-b}{\rho}}(v_i^0 f_i)^b}$ with $\sum_i A_i = 1$

The elasticity of substitution plays a significant role when considering possible tax shifting policies. The elasticity of substitution σ determine the possibility to alter the quantity used of each input factor and is implicitly defined as a point elasticity, i.e., starting from a given (i.e. observed) combination of production factors. In such context, the recent literature on the estimate and use of CES functions for comparative static analysis suggests the normalisation of the production, typically around average values, see in particular Klump et al. (2012) and León-Ledesma et al. (2010). In the dual setting adopted here, the quantity of factors used are apparent in the A_i term such that, in order to identify the relationship between the production factors used, we normalise the value of A_i by considering its average value over the period 2001-2010 for each sector of production. In doing so, we thus assume that the period considered here describes a relatively stable relationship between production inputs, the level of production and production costs. A comparative static analysis can thus be conducted given that these relations are assumed to be stable. We can thus assume that the tax changes alter the total EMTR on production through factor prices only, i.e. considering that the combination of inputs reflects a normal state of affairs.[28] We next carry out a static analysis of changes in the taxation of inputs with constant factor shares moving along the total cost function as a result of the tax-induced change in factor prices. The change in factor prices will thus change the marginal cost (and thus the EMTR) of the firm without altering its total production and cost level. We conduct comparative static analysis considering alternative hypotheses along three dimensions: (i) regarding the extent to which firms can pass the impact of marginal tax increment onto their production factors, represented by β_i, (ii) onto their customer, through μ, or (iii) through the substitution between production factors represented by σ.

Regarding the analysis of (i) and (ii) the term β_i reflects the tax incidence and can be considered to vary from zero (i.e. the firm cannot pass-through the taxes paid on its inputs to its costumers) to one (the taxes paid on inputs to the firm are fully passed-through onto the customers) following the McKenzie et al. (1997) approach. The value of these tax incidence parameters β_i and elasticity of substitution σ is ultimately an empirical issue, however. We thus draw on the existing empirical literature in order to carry out a sensitivity analysis.

3.2 Review of the literature on the parameters

The interactions between labour demand and labour supply will determine the relative influence of tax changes on employers vs. employees. For energy inputs, users and suppliers face specific - and often different - taxes and the shift of the tax burden on either side of the energy markets depends on energy market conditions, i.e., on the elasticity of supply and demand which themselves depend on the market structure, energy source scarcity, short and medium term technical constraints, etc. For capital, a change in taxation will also alter the relative profitability of different investment projects that can eventually lead to changes in business investment types. Hence in all three cases, the relative strength of supply and demand elasticities for inputs will determine the share of taxation of inputs that will be borne by the firm. Second, taxation will affect the mix of inputs used by the firms and an increase tax burden on one input may incentivise firms its substitution with other factors. Similarly, the firm may intentionally (or not shift the tax burden onto other economic agents. For example, higher corporate taxes may result in lower wages. Finally, firms may, depending on their market power, be able to shift a higher tax burden onto their customers in the form of higher

[28] In other words, we assume that the firm maximises ex-ante its production taking as constant the elasticity of substitution between inputs as well as the input shares.

mark-ups. The literature on tax incidence has dealt with these different shifts, see in particular Fullerton and Metcalf (2002).

First, starting with production factors, for all three inputs to production, demand and supply conditions will determine the incidence of taxes on the user cost of a given factor *i* for the firm. They are given by the expression of the direct tax incidence on production factors β_i. The direct tax incidence on production factors is given by the following ratio, combining supply and demand elasticity:

$$\beta_i = \left[\frac{\eta_i^S}{\eta_i^S + \eta_i^D} \right] \tag{11}$$

One should expect that the share of the tax burden borne by the suppliers of the taxed factor decreases as their supply elasticity increases relative to the elasticity of demand (see Feldstein, 1974). The value of β_i should therefore increase if the effects of a tax increase are primarily passed onto firms via production cost. Alternatively the value of β_i decreases if the marginal tax burden is passed onto the suppliers of factors through lower returns, i.e. lower wages (w) for workers, lower pre-tax of return (r) offered to capital owners and lower energy price (P_s).

The relevance of using different values of β_i is especially warranted in the case of labour, since we explicitly distinguish between two types of EMTR depending on which side of the factor demand is being considered. The existing literature on labour tax incidence provides a wide array of results and tends to point to country-specific patterns. For instance Hamermesh (1979) finds that only a third of payroll taxes in the US are actually passed onto workers via lower wages. Gruber (1997) reports that employees face the burden of Chilean payroll tax because of full shifting of the burden from employers into workers earning. Anderson and Meyer (1997, 1998) also find full shifting of the burden of higher payroll tax from employers to workers in the form of lower earnings. In contrast, Bingley and Lanot (2002) find strong evidence in Denmark for partial shifting of the burden of income tax from workers to employers as higher marginal wage tax rates are associated with increases in gross wages and earnings. They show that ignoring the potential labour supply response to a tax change, following the methodology of Gruber (1997) or Anderson and Meyer (1998), as well as ignoring the endogeneity of the marginal tax rate, may lead to the erroneous conclusion that the tax is fully shifted onto labour earnings. With respect to the marginal rate of income tax, their estimated elasticity of gross earnings is 0.36 while the elasticity of gross wages is 0.44 (both showing a partial burden shifting). Ooghe et al. (2007), investigating six European countries (Belgium, Denmark, France, Germany, Italy and Luxembourg), find that over half of social security contributions on employers are passed onto workers. Recent evidence suggests however that the degree of tax incidence from firms to workers depends on the skill levels, which directly affect wage bargaining power. In particular Bauer et al. (2012) find in the German case that low-skilled workers are affected most from business tax shifting, indicating that business-tax incidence involves distributional effects among different categories of workers. Fuest et al. (2012) also provide micro evidence suggesting that low-skilled labour bear a relatively higher burden of the corporate tax bill as well.

The case of capital is more straightforward. Under the traditional open economy assumption capital supply is assumed to be perfectly elastic and the entire burden of capital taxes falls onto capital demand, such that β_k =1, see McKenzie et al., 1997. For large countries such an assumption is unlikely to be validated, however. We will consider alternative assumptions for large countries included in our sample. Considering energy inputs, existing evidence suggests that the buyers of energy products are likely to bear the biggest share of the marginal tax burden. Most recent papers have focused in particular on the tax incidence concerning fuel prices, see in particular Marion and Muelhlegger (2011) and Jametti et al (2013) suggesting that taxes on energy products tend to be fully shifted onto final prices. The assumption made for energy taxes is therefore similar to the case of capital, i.e. we assume that firms are energy price takers such that β_e = 1.

Second, the interaction between the tax burdens of the different production factors needs also to be considered in the analysis in order to capture the real incidence of tax rates on the total production cost. For instance, an increase in corporate taxation is generally considered to affect growth prospects negatively through lower investment and thus reduce earning of other production factors, such as labour, in the long-run, see for instance Feldstein (1974) and the recent empirical evidence provided by Dwenger et al. (2011), Arulampalam et al. (2012) and Fuest et al. (2013). In this study, the elasticity of substitution is by default set to one (full substitutability), although we provide sensitivity analysis.

Finally, another key aspect in our analytical framework concerns the incidence on final consumers[29] via the mark-up margin μ included in equation (4). Accordingly, a greater mark-up will also act as a shift factor of the tax incidence away from the firm total production cost onto final consumers. The evidence available on final product tax incidence concerns very specific products such as cigarettes, TV sets, etc., see in particular Harris (1987) and Karp and Perloff (1989) such that little guidance can be gained from this literature in order to estimate the μ parameter. A better approximation of the potential tax incidence that also fit our analytical framework is therefore to consider the potential existing evidence on the mark-up. The most comprehensive study in this respect is the paper by Oliveira Martins et al, (1996) covering the manufacturing sectors for a number of OECD countries. These authors provide ample evidence for a positive mark-up in most OECD countries and manufacturing sectors suggesting that companies usually fix a positive mark-up on their marginal cost of production such that $\mu > 0$. We use their estimates in order to gauge whether the mark-up rates have an impact on the total EMTR.

4. Effective taxation on total production cost

Using a CES production function, we consider the overall marginal tax burden imposed on firms by combining the EMTR calculated on the three production factors as indicated in equation (8). In order to calculate the weight of each production factor (represented by the term A_i in equation 8), we use the OECD STAN database - that provides the total salary paid by country and sector of activity and the total level of capital investment – and the IEA database on energy purchased by sector and energy source as described in Section 3. The factor-specific weights are averaged over the period 2001-2010 as discussed earlier. Tables A5 to A7 provide the share of capital, labour and energy in total factor spending respectively.[30]

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[29] We do not distinguish explicitly between final household and intermediate firms´ consumption assuming that in each case the same conditions holds in the product markets. This is a simplifying assumption since one might consider that different types of contracts and pricing (depending on whether the final user is an individual or another company) govern market conditions. This is for instance particularly relevant in the case of the energy input. In order to make such distinction one would need more precise information on the supply and demand condition in final vs. intermediary product markets, which is to the best of our knowledge not available on a comparable basis across countries and sectors.

[30] The weights are the highest for the labour factor representing (across country and sectors) 68.1% of the total production costs on average, while capital and energy represent 18.8% and 13.1% respectively. The sectors with the highest energy share are Non-ferrous metals (23.9%), Iron & Steel (25.5%) and Paper, pulp & print (17.3%), those with the highest labour share are Textile & leather (80.2%), Machinery (78.4%) and Transport equipment (73.6%). Finally, those with the highest capital share are Chemicals and petrochemical products

For the remainder of our analysis, we combine all factors of production in order to determine the effective marginal tax rate on total production cost according to the expression in (4) assuming a CES production function. From the perspective of the firm, the relevant part of taxes is the one that increases the production costs *at the margin*. The question we explore next concerns the extent to which the taxes on the three production factors considered do increase the total production cost of a given firm. This in turns leads us to make a number of alternative assumptions drawing on the existing literature on tax incidence discussed above, i.e. the extent to which the demand and/or the supply of each production factor will share the burden of an extra marginal taxation.

The previous review of the literature suggests that there is wide variety of possible assumption regarding the tax incidence parameters. The various cases considered for our sensitivity analysis are summarised in Table (5). Our baseline scenario assumes that firms bear the full burden of payroll taxes (i.e. social security paid by employers) and a third of the labour taxes falling legally onto employees. Next, we also consider the small open economy case and assume in the benchmark that firms bear the full amount of taxes in input capital. We assume equally that firm bear the full amount of the energy taxation and that final product markets are perfectly competitive such that $\mu=0$, i.e. the final price mark-up is zero.

Five alternative scenarios are then considered. In the first scenario, we consider the literature reviewed above and assume that firms only bear half of the tax incidence on their own payroll taxes. In the second scenario, we consider instead that workers, including skilled workers, bear the full amount of the effective marginal tax rate. In a third scenario, we assume that firm can pass half of their capital taxes back onto investors through lower pre-tax returns on capital. In a fourth scenario, we assume that half of the marginal effect of energy taxes can be passed onto energy suppliers. Finally, in a fifth scenario, we consider the case where final product markets are imperfectly competitive and replace the value of the mark-up coefficient (μ) by those values estimated in Oliveira Martins et al. (1996) by country and sector. In addition, we use similar estimates provided by Badinger (2014), Halpern and Kőrösi (2001) and Estrada and López-Salido (2005) for countries not covered in the Oliveira Martins et al. (1996).

(24.0%), Transport equipment (22.7%) and Food & tobacco (22.5%). With a coefficient of variation at 11.3%, the labour input share is by far the most homogenously distributed across countries and manufacturing sectors (compared to 57.2% for energy and 19.6% for capital).

4.1 Effective marginal tax rate on total production cost: country-level results

From our baseline scenario, figure (1) compares the statutory corporate tax rates (category 1 on the horizontal axis) with the value of the EMTs obtained (category 2) when one considers capital taxation only (i.e. as in most of the existing corporate taxation literature), (category 3) when labour taxes are added and (category 4) when the tax on energy is added to capital and labour taxes. In each case the factor-specific weights are corrected in order to arrive at a sum of input shares equal to 100%. Such cross-country comparison is made taking the average values of these indicators across years and sectors of activity. The first interesting feature is the larger dispersion on capital tax rates values when one considers effective marginal vs. statutory tax rates. Some countries such as Belgium, the Czech Republic, Portugal or Sweden experience significant changes in their tax burden when one compares the statutory corporate tax rate with the effective marginal tax rate on capital. Capital (corporate income) taxes are not the only taxes impinging on businesses´ activity and labour represents a large chunk of business costs. Using the CES formulation as in equation (4), we assume that employers taxes fall entirely on firms while only a third of labour taxes on employees is assumed to be shifted to employers through changes in wages (see hereunder for a discussion and sensitivity analysis of the economic incidence). Most countries have now values of the EMTR in the range of 0.2 and 0.4, where France now stands out clearly as the country with the highest EMTR (with average EMTR above 0.4 on average). A number of countries show a low combined EMTR such as Denmark, Ireland, the US, the Netherlands, or the UK. Finally, combining energy taxation for the calculation of the effective marginal tax rate on the total production costs does not fundamentally change the ranking or the dispersion of countries. This reflects the relatively low weight of energy cost and taxes compared to other production factors, although in some countries and sectors of activity this needs not to always be the case.

The results of calculating the EMTR on total production cost following the baseline and scenarios 1 to 5 are reported in Table (6). According to our baseline scenario, the country with the highest EMTR on total production cost is France, with an average EMTR of 41.3%. Three other countries have also a high EMTR: Austria (36.5%), Sweden (34.9%) and Italy (34.8%). Countries with particularly low EMTR values are Ireland (16.8%), Denmark (18.7%), the Netherlands (18.7%), the US (20%) and the UK (21.9%).

Comparing the baseline EMTR with scenarios 1 to 5 does not substantially alter the ranking of countries. The values of the EMTR in certain cases change significantly, however.

For instance while France remains the country with the highest EMTR in all cases, its distinctive position is most altered when considering Scenario 1, i.e. whereby the tax incidence of employers´ payroll taxes is reduced to 0.5. In such case, the EMTR for this country fall by 13.4 percentage points (*pp*) thus illustrating the high burden represented by payroll taxes on total production cost in this country. Other countries would also see their EMTR falls significantly such as Austria (-10.2*pp*), Sweden (-10.9 *pp*), Spain (-9.1*pp*) or Belgium (-9.5*pp*). The fall in the EMTR is also pronounced in Scenario 2 where the incidence of wage taxes is shared. The country most affected in this case is Denmark (-14.5*pp*), followed by Germany (-12.6*pp*), Finland (11.3*pp*), Belgium (11.3*pp*) and Austria (-10.8*pp*). The variations in the EMTR is much less pronounced when considering Scenarios 3 to 4 compared to the baseline scenario thus suggesting that labour taxation is likely to be the most important factor of variation in the EMTR on total production cost, over capital and energy taxes. This result should not come as a surprise given the high level weight of labour in total production costs illustrated earlier. Finally, in scenario 5, the possibility to apply a mark-up and shift taxes to customers has a sizeable impact on the EMTR for Sweden, The Netherlands and Belgium.

We next consider the extent to which cross-sectors difference in factors uses could bear on the overall manufacturing-wide EMTR. In Table (7) we calculate the difference between the weighted average values reflecting the actual sectoral composition and the simple average of sector EMTR by country. A positive sign of this difference would indicate that the sectoral composition of the manufacturing industry tends to increase the overall manufacturing marginal tax rate. The tax and benefit system would thus tend to penalise the manufacturing industry because of its input structure. Overall our results suggest that the tax system tends to be relatively neutral with respect to the structure of manufacturing activity with a slight tendency to bear more on the manufacturing activity. This effect is the most pronounced in Italy, Sweden and the Czech republic although in these three case this effect is moderate and close to 1*pp* only.

Figures (2) and (3) provides further sensitivity analysis for our results. We consider a range of values for the tax incidence, mark-up and elasticity of substitution parameters using as a reference those described in Table (5). Only cross-countries averages are reported here given that the conclusions are qualitative equivalent for all countries considered.[31] First, in Figure (2) we focus on the tax incidence parameters. Each graph alternatively contains the

[31] Country-specific results are available upon request.

surface resulting from setting the baseline value for each tax incidence parameter and considers a uniform grid of eleven values for the other production factors. Moreover, two different assumptions on the mark-up μ are included in panel A (no mark-up) and panel B (positive mark-ups) respectively. Figure (2) displays the difference in EMTR compared to the baseline scenario. A negative (positive) values indicate that our EMTR in the baseline scenario is higher (lower) than the one obtained for each pair of "betas". Unsurprisingly, the baseline scenario always has the highest EMTR. Moreover, the largest volatility of results emerges when the assumptions on the tax incidence for labour vary. Finally, the positive values for mark-ups slightly reduce the volatility of EMTRs. Our results also suggest that for lower tax incidence on labour the role of the mark-up as buffer against tax increase is also attenuated.

Next, Figure (3) focuses on the sensitivity of the EMTR values with respect to the mark-up and the elasticity of substitution, when the values for the tax incidence parameters are fixed. A non-linear surface is obtained when varying both dimensions (μ and σ) which also reflects the way that these parameters enter the formula on the total EMTR. Importantly, varying the mark-up seems to induce more volatility in the estimated EMTRs than considering different values for the elasticity of substitution between the production factors. This result confirms our earlier results and underlines the importance of considering the final product market structure faced by firms when analysing the incidence of possible tax reforms on economic activity.

4.2 The impact of a tax policy shift

One of the benefits of our approach is that we can jointly discuss the role of different productive factors in the overall production cost structure. We can therefore analyse how the global EMTR would change if tax policy would decide to shift some proportion of tax burden applied to one factor to another one (i.e. tax shift). In this section, we aim to illustrate the potential effects of a budget-neutral tax shift between labour and energy.[32] This type of reforms has long been advocated as a way to effectively reduce CO2 emissions while improving employment (see Bovenberg and de Mooij, 1994) and providing incentives to improve cost effectiveness and innovation through improved energy efficiency, see in

[32] The budget neutrality is ex-ante as our model is static such that possible behavioral effects that could lead to a change in the tax bases or economy-wide interactions are not considered.

particular, European Commission (2011) and OECD (2006, 2010).[33] To analyse the consequences of such reforms, we simulate the impact of a reduction of the tax revenue collected on labour through payroll taxes and a simultaneous increase in the taxes collected on energy products on the total EMTR. Such simulation is relatively straightforward since the effective energy tax used is an average tax rate while the payroll taxes is in most cases a flat tax on payroll to be paid by employers.[34] These two taxes can therefore be changed directly to reflect the change in the tax revenue collected. The procedure we follow is to consider a decrease in the payroll tax rate, then estimate the amount of foregone payroll tax revenues in order to derive the tax rate on energy that is needed to compensate for this foregone tax revenue. The increase in energy taxes is thus derived ex-post in order for the tax collected by the tax authorities to remain unchanged. Note that in doing so we need to assume that the variations in the implicit tax rates are identical to those of the effective tax rates and that the entire burden of the payroll tax reduction falls back onto companies.

Figure (4) shows the alternative overall EMTR when increasing deviations from baseline scenario are considered. To fix ideas, we consider alternative scenarios ranging from 5% to 100% decreases in the payroll tax rate using a bandwidth of 5 percentage points. A reduction of 100% in the payroll tax thus corresponds to the abolition of such tax. The impact of changes on the “all-in” EMTR differs in magnitude across countries. It is most pronounced in those countries that have a high EMTR for payroll taxes paid by employers.[35] Interestingly, the pattern of EMTR appears in many instances non-linear and heterogeneous across countries. However, we observe an almost general decline in the resulting EMTR (and, consequently, efficiency gains) if the tax shifting operated is ambitious enough, except for the Netherlands where a slight increase in the total EMTR can be observed. In countries such as Austria, Sweden and France, the largest reductions in EMTR are obtained in case of a full shift (close to 10 percentage points decrease in the all-in EMTR) while the impact of the shift would be relatively modest in the UK or the US (less than 2 pp). Finally, institutional factors are also helpful to explain some of the trends observed. For instance, those countries in which payroll taxes are relatively low (NL, and US) or non-existent (DK) are those in which the change of the EMTR is the lowest. These simulations are of course subject to a number of

[33] The change in firms´ production cost entailed by tax shift reforms can yield a competitive advantage as long as their design allow firms to lower their production cost and/or develop their innovative capability. For instance, Porter (1995) suggests that green taxes can lead firms to develop a competitive edge through forced green innovation, which may yield a productivity gain.

[34] We do not consider alternative tax shifts between capital and labour since the equivalence between marginal and average tax rates is not verified for capital.

[35] Inversely, in the case of Denmark, there is no possible shift as there are no payroll taxes.

caveats. We assume in particular that productive factors shares remain unchanged when the tax shifting is implemented thus excluding possible changes in production structure that could alter the relative proportion in which production factors are used. Our analysis also assumes that the entire tax loss due to the payroll tax reduction is met by an increase in energy taxes in order to leave the total tax revenues unchanged. In practice governments avail of a large battery of taxes whereby the compensating tax increases can in fact fall onto multiple taxes. For instance countries aiming at improving their competitive position vis-à-vis the rest of the world might want to increase consumption taxes in order to compensate for the revenue loss due to the payroll tax reduction and, at the same time, favour export against domestic consumption. The increase we impose on the energy tax rate must therefore be considered as an upper bound of the increase required in energy taxes since governments would in principle aim at favouring the competitive position of their domestic firms. Table (8) provides an indication of the changes operated in the energy taxes needed to compensate the loss in payroll tax revenues in the simple case considered here. As can be seen, in most cases energy taxes need to go beyond 100% and up to more than 400% as in the Austrian or the Swedish cases. The simulation results on the tax shifting scenarios provided in Figure (2) thus suggest that, even in such arguably extreme scenarios, substantial reduction in the EMTR can be achieved through tax shifting policies.

Figure (5) considers the same tax shifting scenarios with different elasticity of substitution with, as before, tax rate reduction from 5% to 100% in the payroll taxes compensated by an increase in the energy taxes for the year 2010. These simulations illustrate the additional gain obtained through tax shifting policies when the degree of substitution between production factors increase. There are arguably only a handful of studies providing estimation of the elasticity of substitution for different countries and sectors of activity. Our aim here is merely to illustrate the way the benefits of tax reforms can be altered when firms avail of greater flexibility in their use of production factors. To do so we consider, together with the benchmark case where σ equals 1, cases where this values is zero (i.e. as in a Leontieff production function) and alternatively 0,5 and 1,5. These values are chosen in accordance of the review of findings provided by Klump et al. (2012). We also consider an alternative case where the value of σ differs across sector of production considering the estimates provided by Bentolila and Saint-Paul (2003). In general these sector-specific elasticities are close to 1 such that this alternative scenario unsurprisingly yields results close to the Cobb-Douglas case where $\sigma=1$. Figure (5) shows that in all cases the greater the value of the elasticity of substitution *σ,* the larger the lower the level EMTR and the larger the gains obtained from the tax shift reform. These results also confirm that the sector-specific case is indeed close to the Cobb-Douglas specification. As the elasticity of substitution differs and the CES function specification is non-linear as illustrated in the previous section, the differences in the total EMTR reduction obtained after a tax shift reform is magnified for very large reduction in the payroll taxes.

Figure (6) and (7) further illustrate the differences in EMTR reduction in 2010 and considering a partial (50%) and full (100%) tax shift scenario in each of the incidence scenario by country and sectors of activity. The amount EMTR *reduction* is indicated with a *positive* sign on the y-axis. For instance in figure (4), in Austria, a 100% shift would reduce the total EMTR by 10 *pp* if scenario 3 was considered. Interestingly enough, the shape of the change in the EMTR reduction is also very similar across countries. Moving from the baseline to Scenario 1 unsurprisingly reduce the amount EMTR reduction (indicated with a positive sign in the y-axis), indicating that a lower tax incidence of employer payroll taxes on firms tends to reduce the advantage of the tax shifting policy. A similar reduction in observed when moving from the baseline to Scenario 2 where the incidence of the employee tax on firms is equal to zero. These results therefore indicate that the higher the tax incidence of both labour taxes, the larger the benefit of the tax shift policy lowering labour taxes and increasing energy taxes. The gain in the EMTR reduction is also lower when considering a lower incidence on capital taxes, i.e. when moving to Scenario 3. In this case however the reduction in the EMTR is much closer to the benchmark case. This result is unsurprising given that capital taxes are left unchanged in the tax policy simulation. Considering now the low-energy tax incidence scenario (i.e. Scenario 4) yields similar albeit slightly higher EMTR gain compared to the partial capital tax incidence case. Overall the EMTR reduction is slightly lower compared to the benchmark case thus indicating that a lower tax incidence on energy tends to reduce the gain from potential tax shift between labour and energy tax. Again, this result appears rather logical given the relatively low burden represented by energy costs on average across the countries and sectors considered. A similar result emerges when considering the possibility for firm to have a positive mark-up over their marginal cost. All in all therefore, the gain from a tax shifting strategy like the one considered here is primarily conditioned by the tax incidence on labour, be it employee or employer taxes. Remarkably enough, this result holds for all countries considered here. Finally, Figure (7) provides a similar sensitivity analysis for each sector. Unsurprisingly, the gains are the highest in those sectors with the highest labour share (Textile and Leather, Transport) and lowest in those with the highest energy share (Non-Ferrous Metals, Iron and Steel, and Paper, Pulp and Print). It is interesting to note that in almost all cases, such shift actually leads to a decrease in the total EMTR.

5. Conclusions.

This paper provides estimates of the effective marginal tax rate (EMTR) in a single framework encompassing capital, labour and energy taxes for a sample of 17 OECD countries and 11 manufacturing sectors. The use of the EMTR and its comparison across sectors and countries is particularly useful when assessing the potential consequences of tax policy changes on the total cost of business activity. To date, however, existing studies have focused on capital taxation only. Research in support of tax policy formulation should consider other production factors as well, especially when devising strategies aimed at shifting the tax burden in order to favour growth and employment creation. In particular, our cross-country/cross-sector approach allows us gauging the effects of tax changes on the incentives provided by the tax system to increase economic activity. We take explicitly into account the economic incidence of the various taxes on inputs, the possible substitution between these inputs and the possible pass-through of additional tax burdens onto customers. To do so, we combine estimates of the EMTR on capital with indicators on the EMTR concerning energy products and EMTR on labour to obtain an “all-in” EMTR. We then conduct an analysis of the impact of alternative tax shifting between production factors to illustrate the usefulness of our results for comparative static tax policy analysis. Our results suggest that strategies favouring tax increases on energy consumption and lowering taxes on labour can entail significant reduction in the total marginal cost of increasing factor use.

This work is arguably the first cross-country/cross-sector study providing a synthetic and comparable measure of the effective marginal tax rate in a multi-production factors framework based on detailed tax codes. Because it is the first of the kind, it also faces a number of limitations that could be tackled in future research. For instance, the tax treatment of inventories or financial assets has not been considered due to a lack of data. Our analysis has also focused on the manufacturing industry, thus excluding the services sectors, which represents two third of total economic activities. Additional EU and non-EU countries could be added to the dataset, although this depends to a large extent on future data availability. We have also dealt with the potential interaction between tax incidence and product market structure indirectly by altering mark-up rates in final product pricing. Further work could aim at embedding indirect (value-added) taxation in the analysis in order to enrich policy interpretation of the results. Considering VAT would also allow analysing the interactions between changes in indirect taxation on consumption (i.e. mostly VAT in EU countries) and changes in the taxation of factor used (e.g. labour) which are often put forward in EU or OECD policy recommendations.

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Figures

Figure (1): Effective Marginal Tax rates on capital, labour, energy and on total production cost (country-average results for 2001-2010)

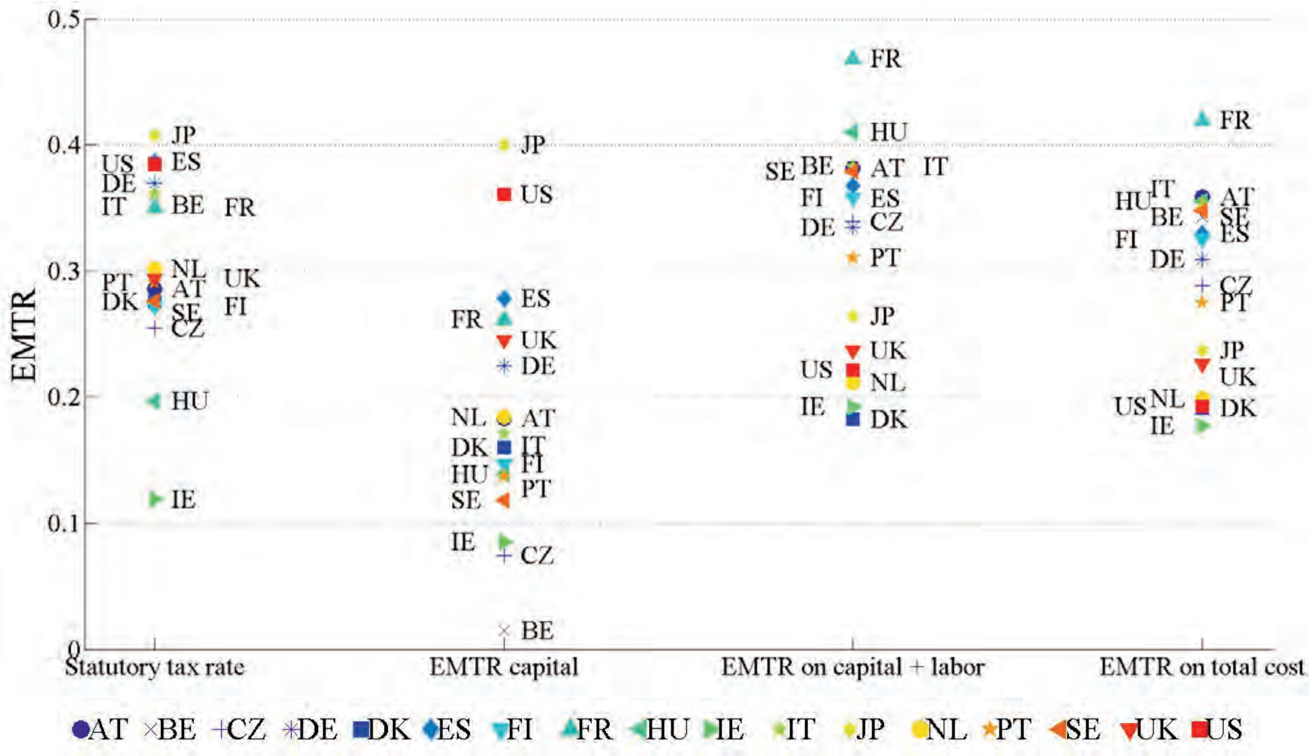
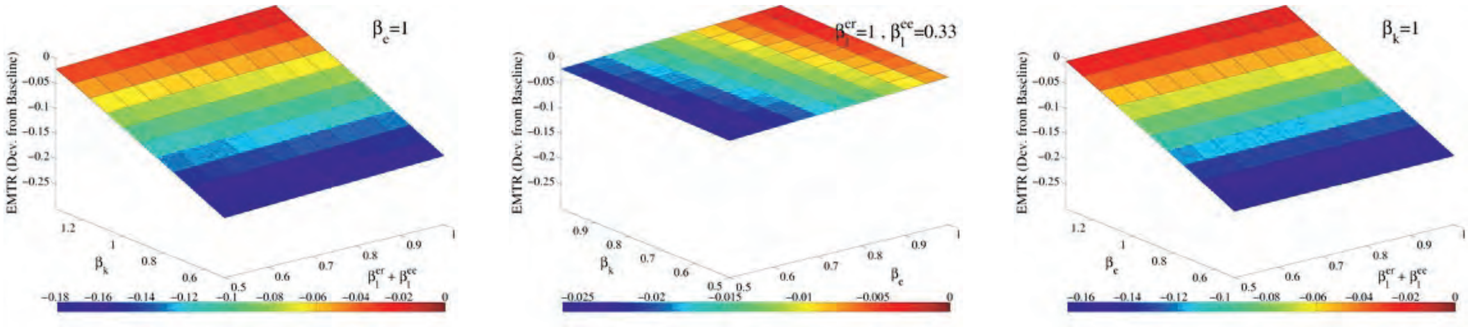


Figure (2): Effective marginal tax rate on total production cost by tax incidence scenario (difference comparing to baseline): Difference vs. baseline averaged across-sectors and countries for 2001-2010

Panel A: μ=0



Panel B: μ≥0

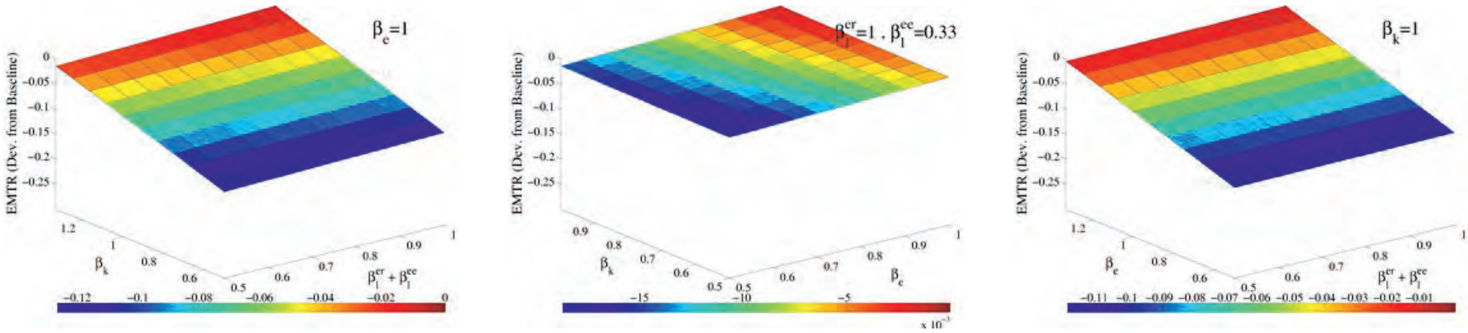


Figure (3): Effective marginal tax rate on total production cost by mark-up (μ) and elasticity of substitution (σ) scenarios: Difference vs. baseline averaged across-countries for 2001-2010

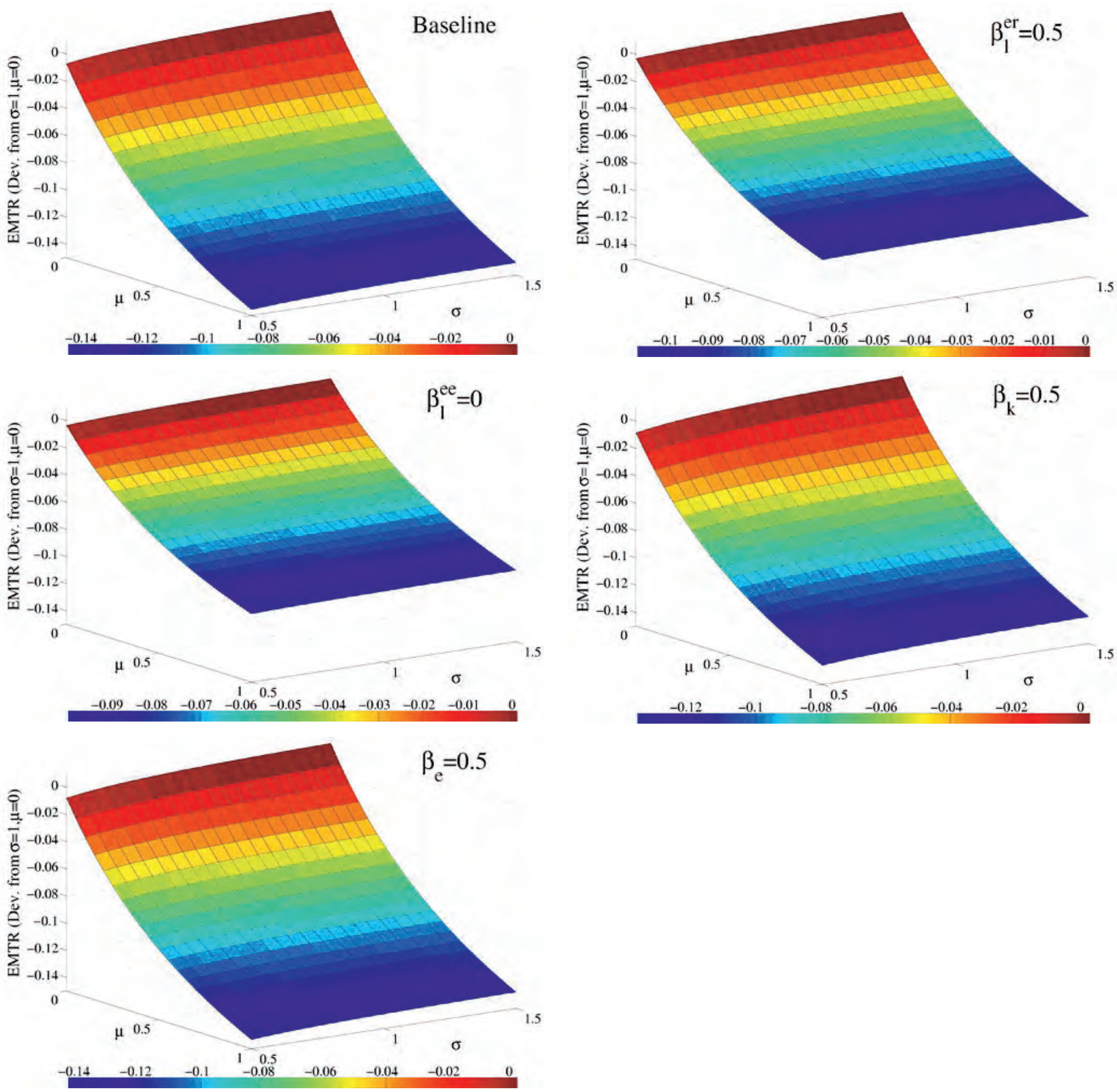
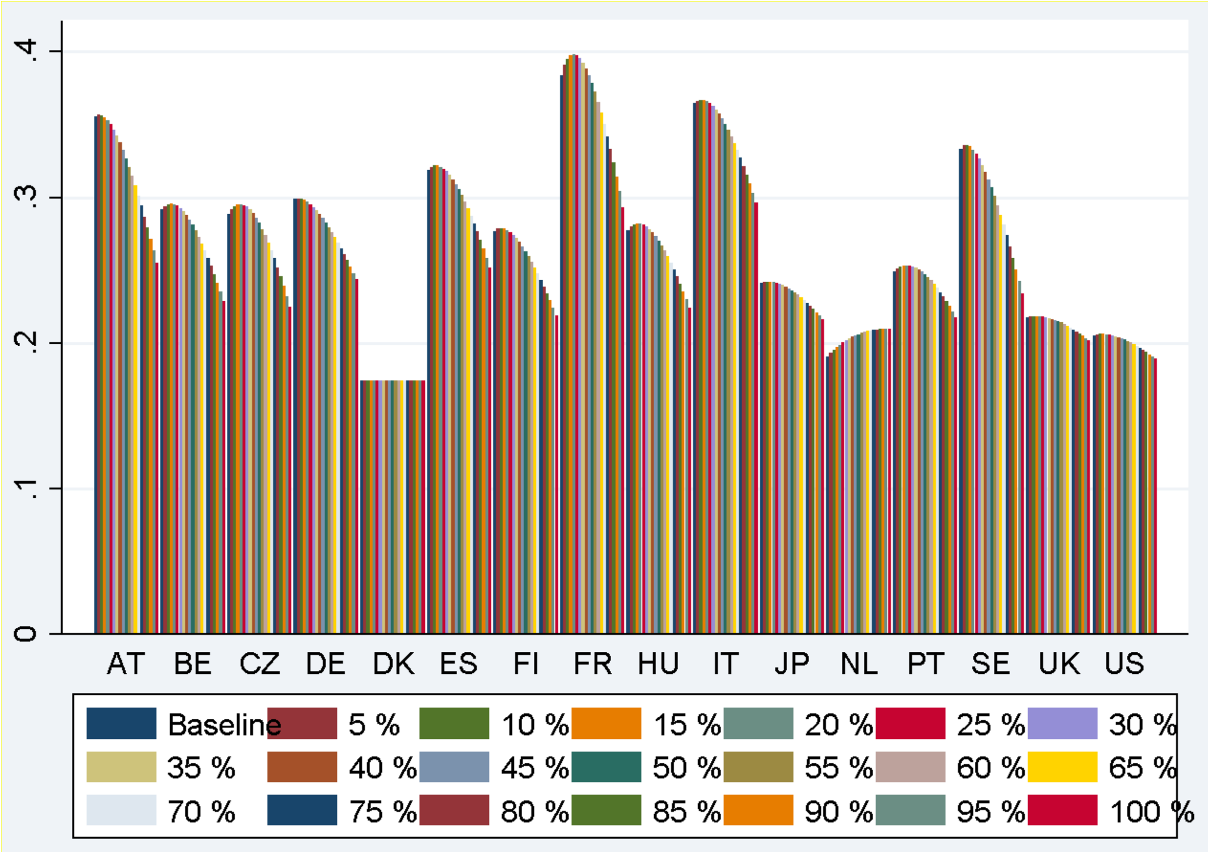


Figure (4): Labour to Energy Tax Shifting Simulation (results for 2010)



Notes:
(1) EMTR corresponds to baseline scenario with parameters as specified in Table 10.
(2) Range of deviation from 0 %-Baseline- to Full Shifting (100 %) of Employers' EMTR
(3) The absence of change for DK is due to the fact that DK does not levy social security contributions on employers.

Figure (5): Labour to Energy Tax Shifting Simulation. (country-average results for 2010) – Results under alternative elasticity of substitution (*b*).

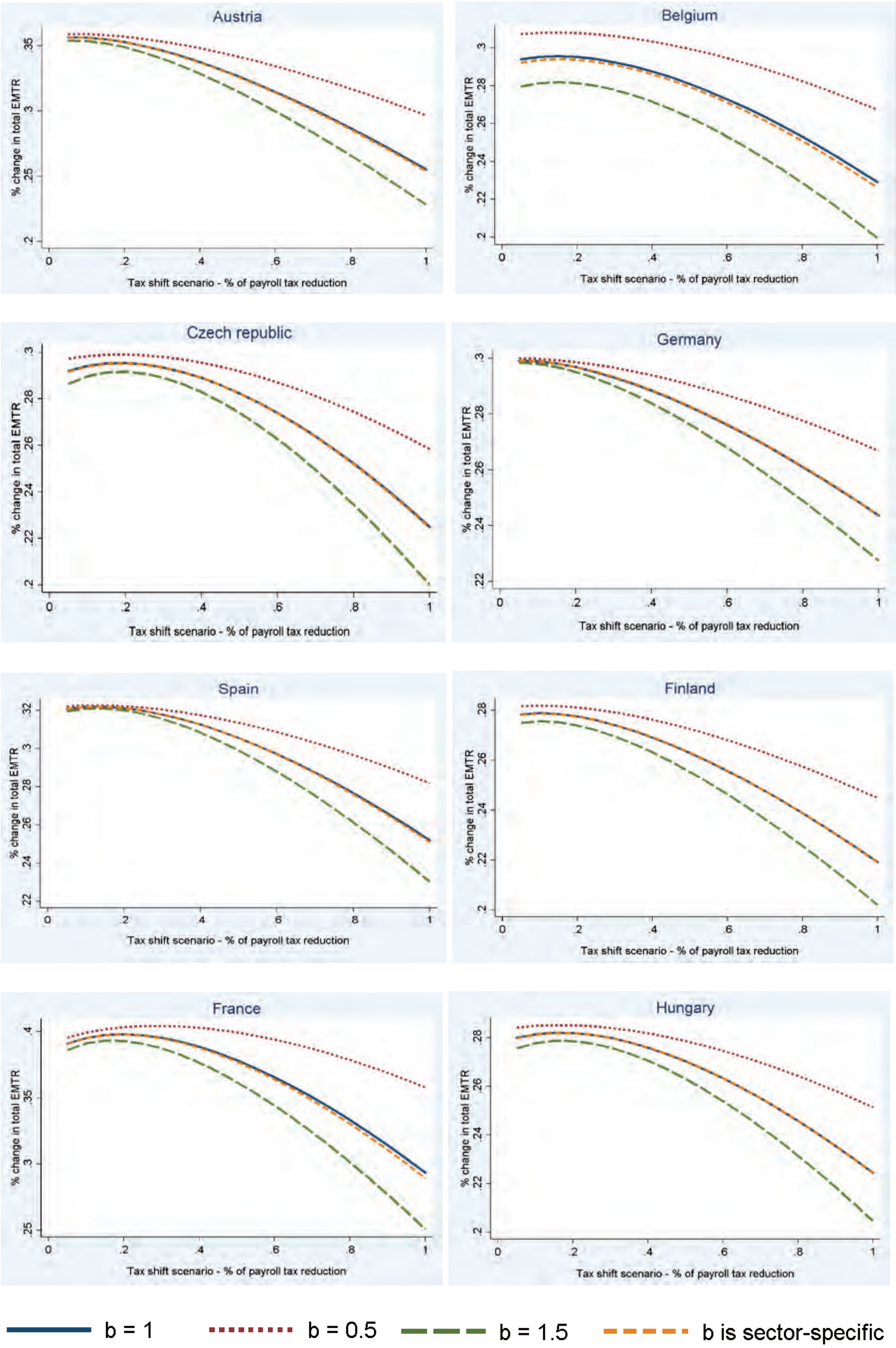


Figure (5) - *continued*: Labour to Energy Tax Shifting Simulation. (country-average results for 2010) – Results under alternative elasticity of substitution (*b*).

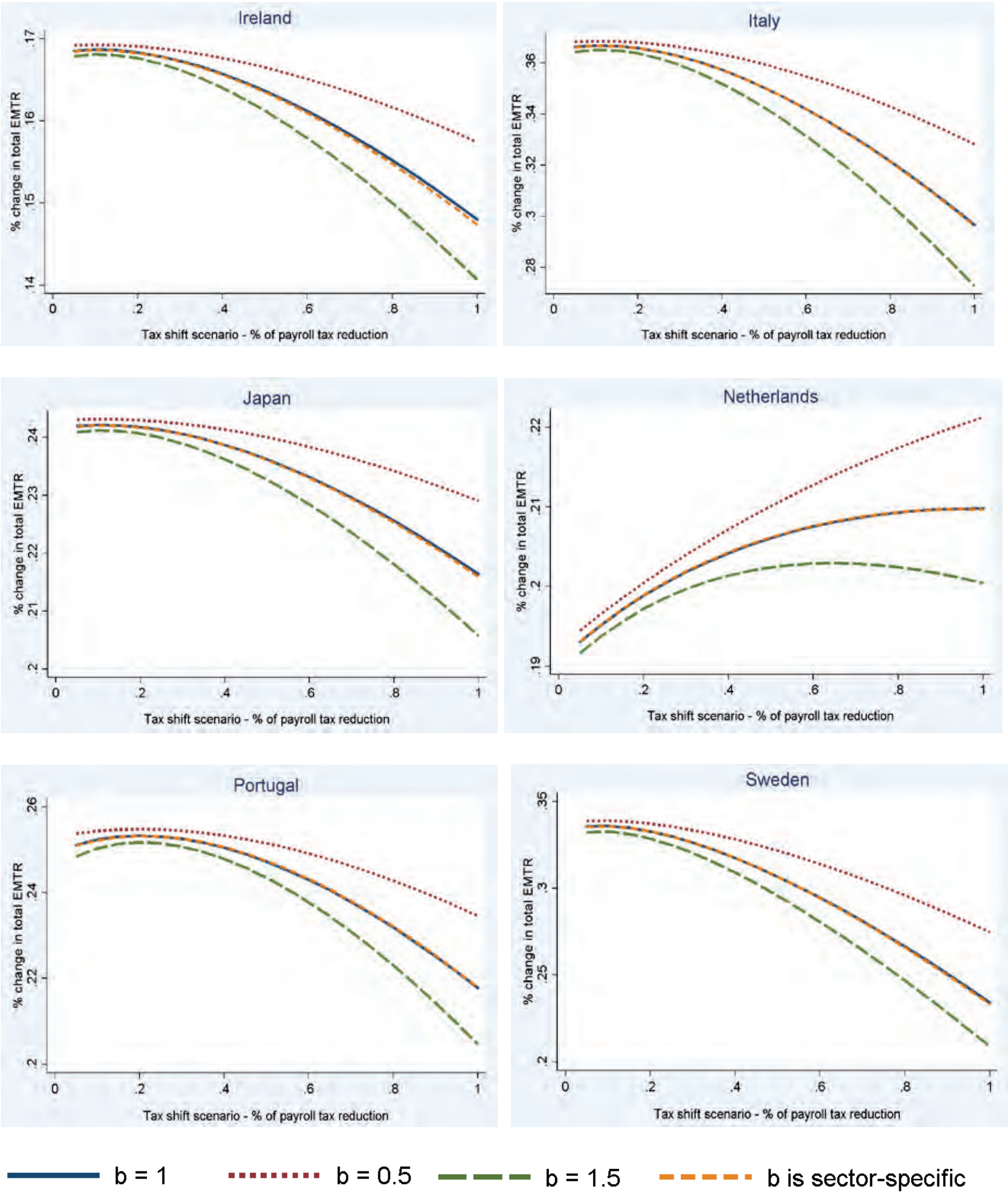


Figure (5) - *continued*: Labour to Energy Tax Shifting Simulation. (country-average results for 2010) – Results under alternative elasticity of substitution (*b*).

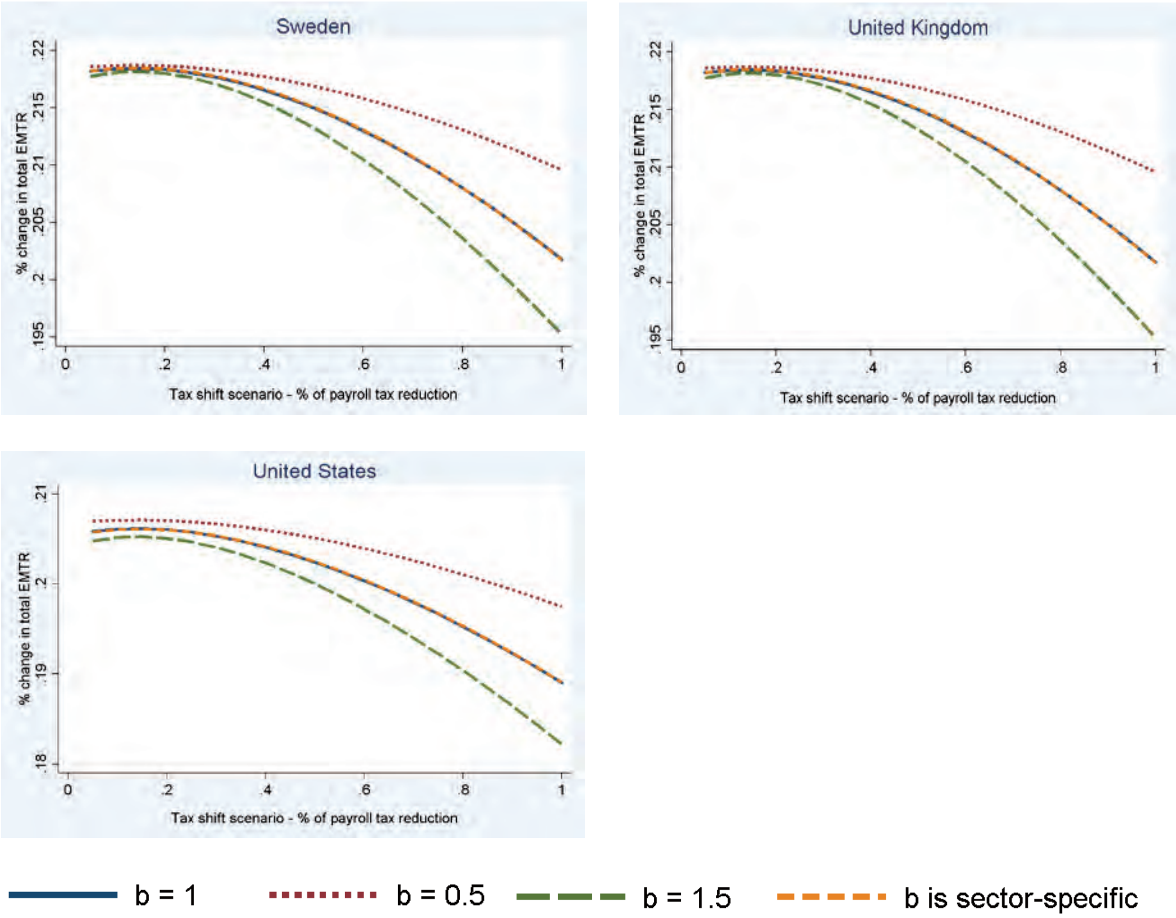
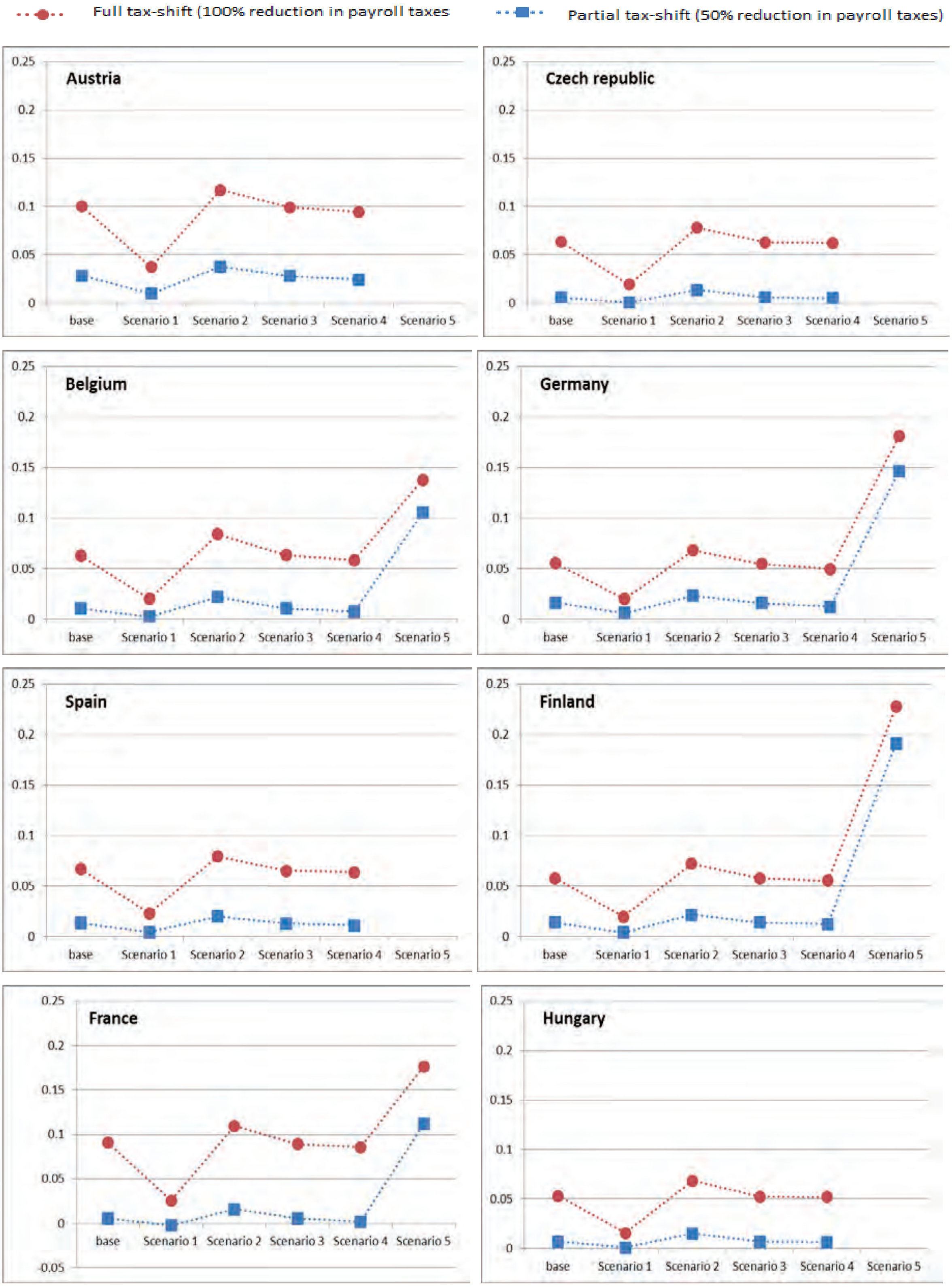
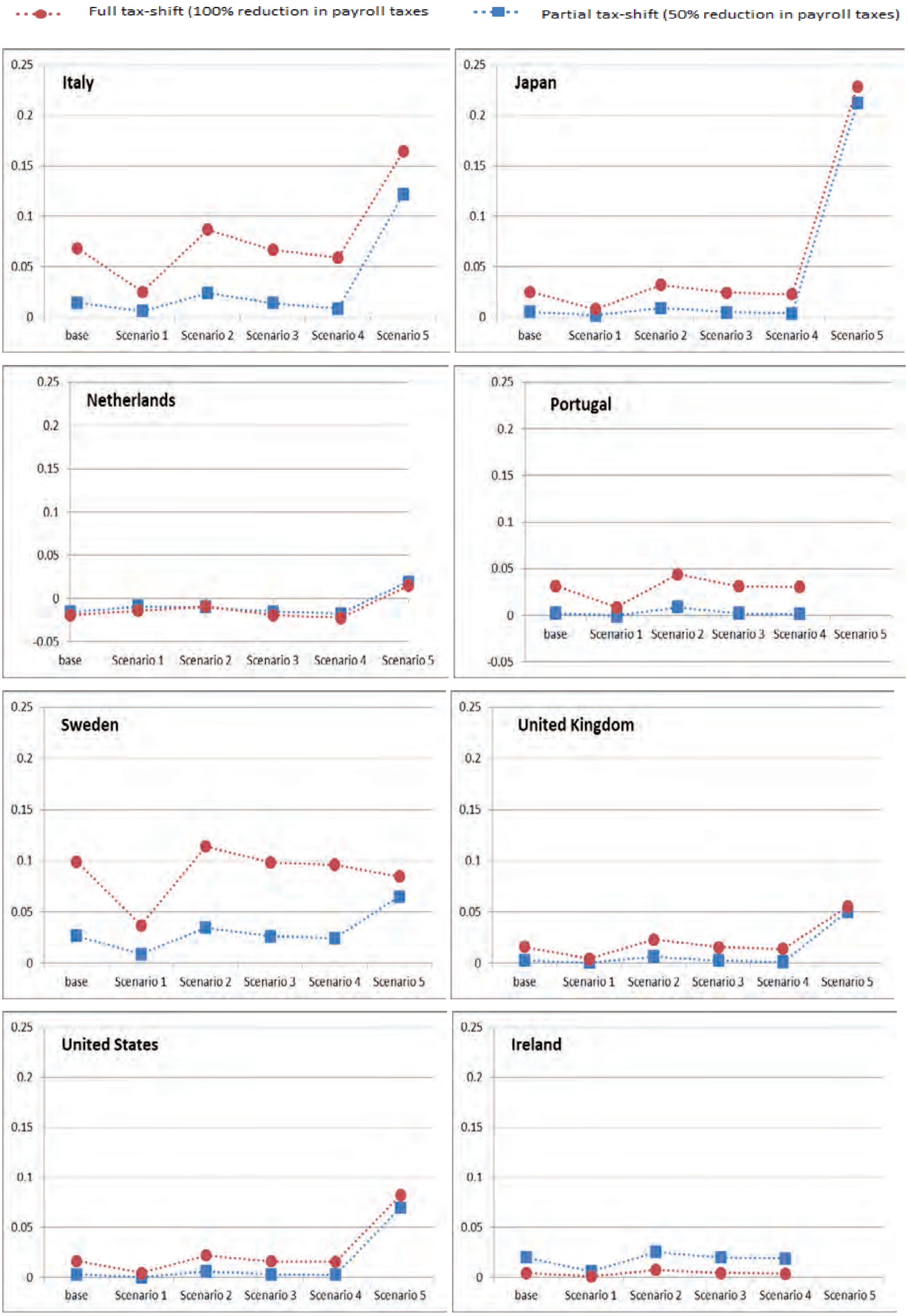


Figure (6): Change in the effective marginal tax rate with partial and full tax shift and by tax incidence scenario: results by country for 2010.



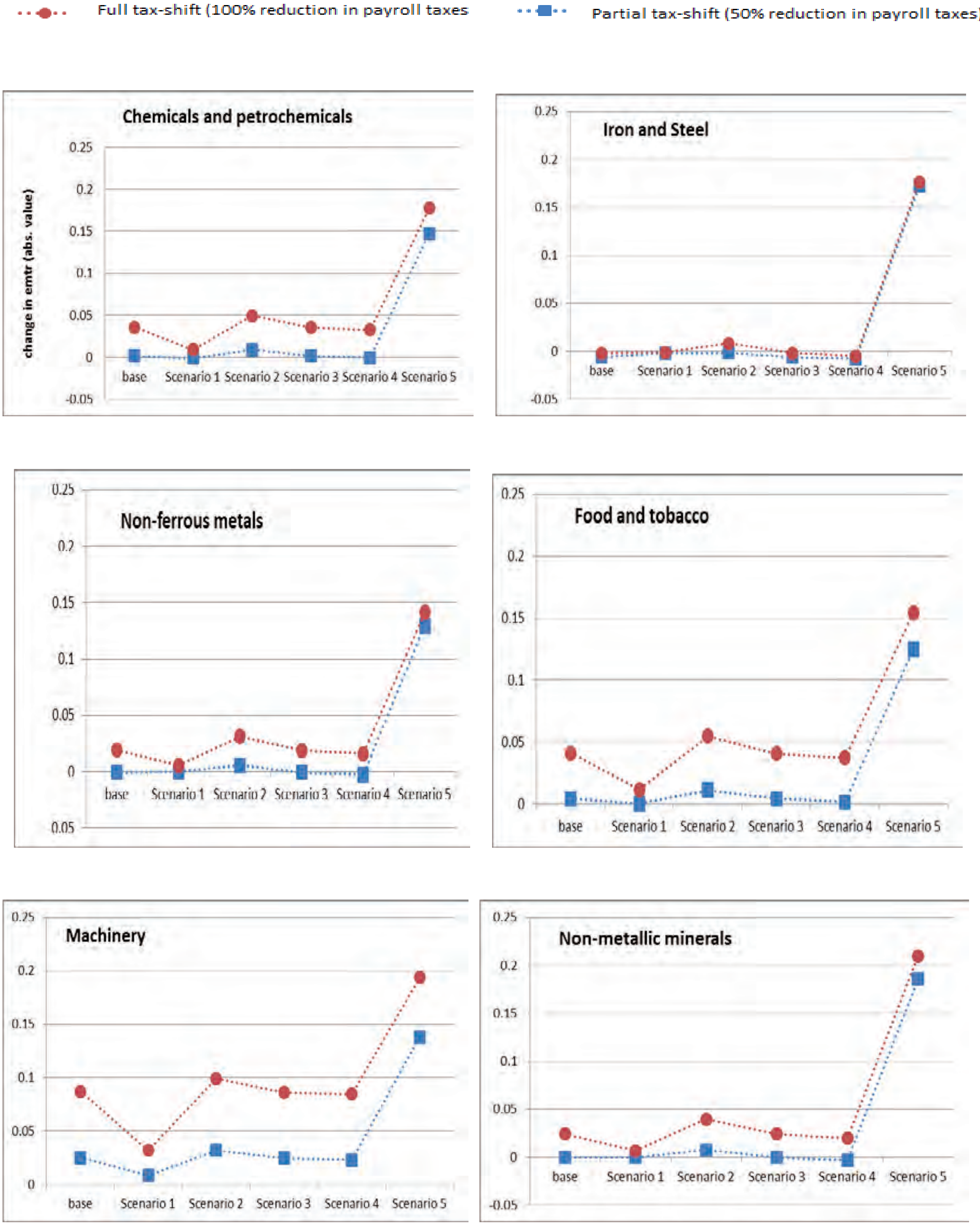
Note: the Tax shift corresponds to a 50% and 100% reduction in effective payroll tax paid by firms and a compensating increase in the energy tax.

Figure (6) - continued: Change in the effective marginal tax rate with partial and full tax shift and by tax incidence scenario: results by country for 2010.



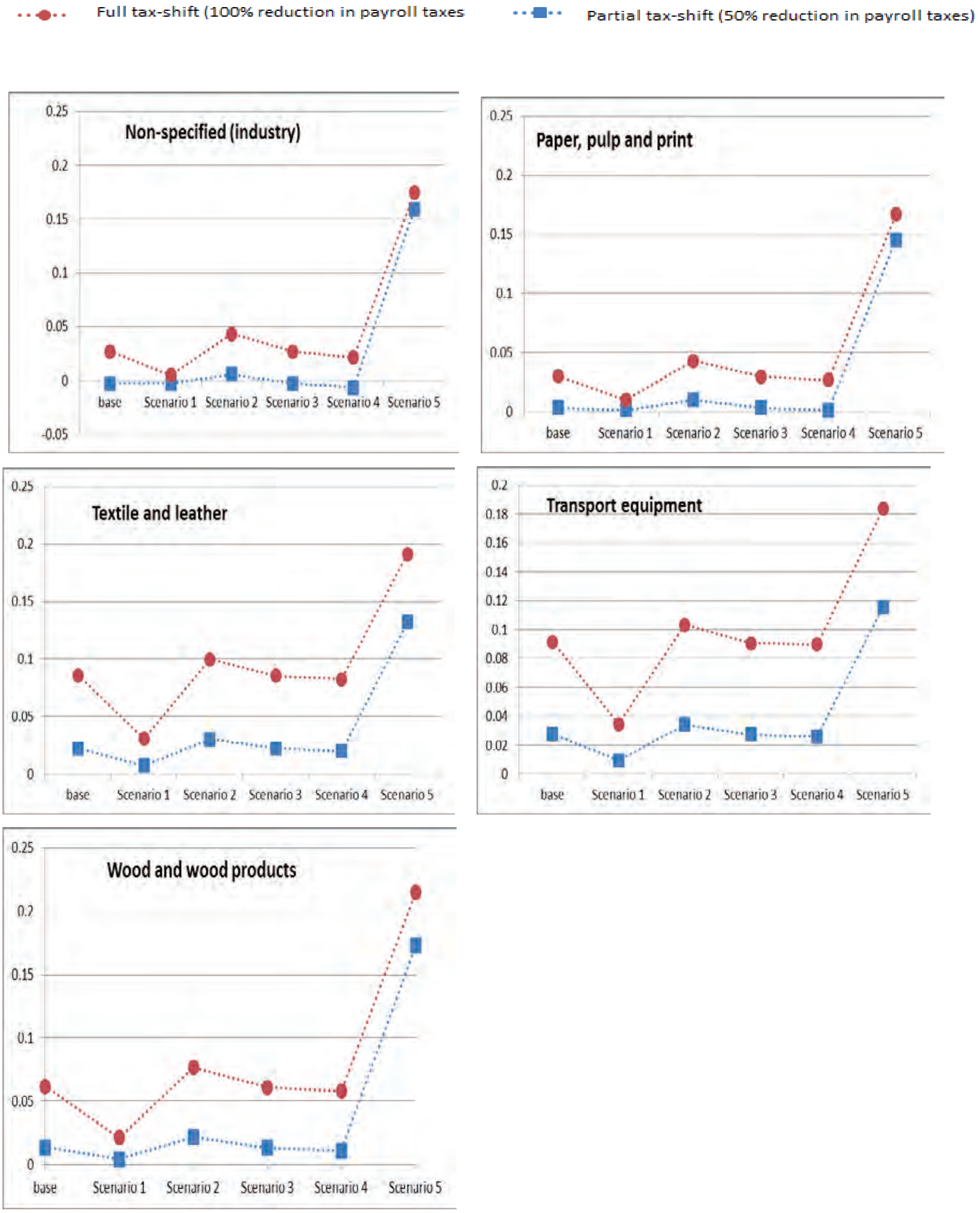
Note: the Tax shift corresponds to a 50% and 100% reduction in effective payroll tax paid by firms and a compensating increase in the energy tax.

Figure (7): Change in the effective marginal tax rate with partial and full tax shift and by tax incidence scenario: results by sector for 2010.



Note: the Tax shift corresponds to a 50% and 100% reduction in effective payroll tax paid by firms and a compensating increase in the energy tax.

Figure (7) - continued: Change in the effective marginal tax rate with partial and full tax shift and by tax incidence scenario: results by sector for 2010.



Note: the Tax shift corresponds to a 50% and 100% reduction in effective payroll tax paid by firms and a compensating increase in the energy tax.

Tables

Table (1): Effective Marginal Capital Tax Rates (average across all assets)

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	17.7%	18.5%	18.2%	18.0%	17.7%	18.9%	18.6%	18.0%	18.1%	18.9%	18.5%	18.3%	0.4%	2.3%
Belgium	2.4%	-8.2%	5.9%	3.8%	2.8%	-4.0%	2.2%	3.3%	4.8%	-1.7%	4.9%	1.5%	4.3%	291.9%
Czech republic	5.9%	12.4%	5.5%	5.2%	8.5%	10.1%	7.4%	7.1%	4.7%	5.9%	9.1%	7.4%	2.4%	32.1%
Denmark	12.5%	9.9%	18.2%	18.3%	18.6%	17.4%	17.8%	17.3%	17.7%	17.1%	11.1%	16.0%	3.2%	19.9%
Finland	14.9%	14.9%	14.6%	14.9%	15.1%	14.5%	15.1%	13.4%	15.5%	14.0%	14.5%	14.7%	0.6%	3.9%
France	27.0%	24.8%	26.9%	27.2%	25.7%	24.7%	25.5%	26.2%	27.4%	26.3%	26.0%	26.2%	0.9%	3.5%
Germany	22.5%	21.8%	23.1%	22.9%	22.0%	21.8%	22.3%	22.5%	23.2%	22.7%	22.5%	22.5%	0.5%	2.1%
Hungary	14.3%	13.9%	15.3%	14.9%	13.2%	12.2%	14.1%	13.9%	15.6%	11.9%	13.2%	13.9%	1.2%	8.4%
Ireland	7.5%	9.4%	8.1%	8.7%	7.9%	9.7%	8.6%	8.2%	9.0%	8.2%	8.3%	8.5%	0.7%	7.8%
Italy	16.6%	14.7%	20.9%	17.6%	15.5%	14.7%	20.9%	16.8%	18.5%	16.1%	16.1%	17.1%	2.2%	12.6%
Japan	39.8%	40.0%	40.1%	40.0%		40.1%	40.0%	39.9%			40.2%	40.0%	0.1%	0.3%
Netherlands	18.3%	19.1%	19.1%	18.5%	18.9%	18.4%	19.2%	17.1%	18.7%	17.3%	17.9%	18.4%	0.7%	3.8%
Portugal	11.7%	14.7%	12.3%	11.8%	17.5%	18.3%	15.8%	12.5%	11.8%	12.0%	12.9%	13.8%	2.4%	17.7%
Spain	27.6%	27.2%	28.3%	28.2%	27.1%	27.9%	28.5%	27.3%	28.0%	27.9%	28.2%	27.8%	0.5%	1.7%
Sweden	12.3%	11.4%	12.3%	12.2%	11.6%	11.3%	11.2%	11.9%	12.5%	11.5%	12.0%	11.8%	0.5%	3.9%
United Kingdom	22.2%	23.0%	26.0%	25.3%	21.9%	23.5%	23.1%	24.9%	27.4%	26.8%	27.4%	24.7%	2.1%	8.4%
United States	35.9%	36.6%	35.8%	35.9%	36.1%	36.5%	36.1%	35.8%	35.8%	36.2%	36.1%	36.1%	0.3%	0.8%
average	18.2%	17.9%	19.4%	19.0%	17.5%	18.6%	19.2%	18.6%	18.0%	16.9%	18.8%	18.4%	0.8%	4.1%
Standard dev.	10.1%	11.0%	9.8%	10.0%	8.2%	10.4%	9.8%	9.8%	8.7%	9.5%	9.9%	9.7%		
Stdev./avg.	55.6%	61.8%	50.4%	52.5%	46.7%	55.9%	51.0%	52.9%	48.2%	55.9%	53.0%	53.0%		

Sources: ZEW and authors´ calculations

Table (2): Effective Marginal Employers Payroll Tax Rates

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	28.1%	28.3%	28.1%	28.6%	28.0%	28.1%	28.8%	28.2%	28.8%	28.7%	28.7%	28.4%	0.3%	1.1%
Belgium	30.8%	30.6%	30.6%	30.1%	30.8%	30.8%	30.1%	30.3%	29.8%	30.0%	30.6%	30.4%	0.4%	1.2%
Czech republic	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	34.8%	0.0%	0.0%
Denmark	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Finland	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	23.9%	0.0%	0.0%
France	42.6%	42.6%	42.0%	41.1%	42.9%	42.7%	41.0%	41.2%	40.1%	40.5%	42.2%	41.7%	1.0%	2.3%
Germany	19.2%	18.8%	18.9%	19.6%	18.7%	18.7%	19.7%	19.5%	19.8%	19.6%	19.2%	19.2%	0.4%	2.2%
Hungary	34.9%	34.8%	34.7%	35.1%	34.7%	34.8%	35.2%	34.8%	35.6%	35.3%	35.3%	35.0%	0.3%	0.9%
Ireland	11.0%	10.8%	10.5%	10.6%	10.8%	10.8%	10.6%	10.6%	10.5%	10.6%	10.8%	10.7%	0.2%	1.5%
Italy	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	0.0%	0.0%
Japan	12.9%	12.9%	12.9%	13.0%		12.7%	13.0%	13.0%			13.0%	12.9%	0.1%	0.9%
Netherlands	10.4%	8.9%	8.7%	10.8%	10.6%	8.8%	10.6%	8.9%	11.1%	10.9%	10.8%	10.0%	1.0%	9.8%
Portugal	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	0.0%	0.0%
Spain	30.1%	30.0%	29.9%	30.2%	29.9%	29.9%	30.2%	30.0%	30.3%	30.3%	29.9%	30.1%	0.1%	0.5%
Sweden	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	0.0%	0.0%
United Kingdom	10.5%	10.8%	10.6%	10.3%	10.9%	10.9%	10.5%	10.6%	9.9%	10.3%	10.4%	10.5%	0.3%	2.7%
United States	9.0%	8.7%	8.7%	9.0%	8.7%	8.7%	9.0%	8.7%	9.0%	9.1%	9.0%	8.9%	0.1%	1.6%
average	22.7%	22.6%	22.5%	22.7%	23.3%	22.6%	22.7%	22.6%	23.3%	23.3%	22.8%	22.8%	0.3%	1.4%
Standard dev.	11.9%	12.1%	12.0%	11.8%	12.1%	12.1%	11.8%	11.9%	11.9%	11.9%	11.9%	11.9%		
Stdev./avg.	52.5%	53.3%	53.4%	52.0%	51.7%	53.5%	52.0%	52.8%	50.9%	50.9%	52.3%	52.3%		

Sources: OECD Taxing wage database and authors´ calculations

Table (3): Effective Marginal Employees Wage Tax Rates (Personal Income Tax and Social Security Contributions paid by employees)

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	45.2%	45.1%	45.3%	44.2%	46.4%	47.1%	44.2%	44.6%	44.2%	44.1%	44.4%	45.0%	1.0%	2.2%
Belgium	54.4%	54.7%	54.7%	53.2%	55.1%	55.0%	54.3%	53.5%	60.5%	55.8%	53.4%	54.9%	2.0%	3.6%
Czech republic	33.2%	32.3%	32.9%	31.8%	33.1%	33.3%	32.0%	32.4%	36.4%	34.7%	33.8%	33.3%	1.3%	4.0%
Denmark	55.5%	58.6%	55.3%	58.6%	55.5%	56.7%	58.2%	56.1%	58.8%	55.9%	55.7%	56.8%	1.4%	2.5%
Finland	50.0%	46.6%	45.7%	49.4%	50.9%	49.9%	48.6%	48.1%	51.4%	51.5%	52.7%	49.5%	2.1%	4.3%
France	31.1%	31.4%	31.5%	33.0%	31.0%	31.6%	38.5%	32.7%	40.1%	34.2%	31.3%	33.3%	3.1%	9.4%
Germany	51.5%	49.6%	51.3%	51.1%	49.1%	50.5%	48.3%	50.1%	45.7%	46.1%	51.6%	49.5%	2.1%	4.2%
Hungary	57.1%	53.9%	59.1%	54.5%	58.8%	58.8%	55.0%	59.2%	39.0%	47.9%	56.1%	54.5%	6.1%	11.2%
Ireland	27.7%	30.4%	31.6%	58.0%	37.5%	31.2%	29.5%	29.4%	40.8%	36.2%	30.3%	34.8%	8.7%	25.0%
Italy	45.8%	46.0%	40.1%	40.6%	43.4%	41.1%	40.5%	40.4%	45.2%	42.1%	46.0%	42.8%	2.5%	5.8%
Japan	25.6%	26.4%	26.3%	26.4%		28.4%	37.6%	27.8%			37.0%	29.4%	4.9%	16.8%
Netherlands	35.3%	31.5%	38.6%	42.7%	28.3%	32.5%	29.2%	17.4%	49.5%	41.8%	42.2%	35.4%	8.9%	25.1%
Portugal	33.3%	35.7%	39.1%	36.3%	38.8%	38.8%	35.3%	38.9%	36.9%	35.1%	39.0%	37.0%	2.0%	5.5%
Spain	29.3%	29.4%	29.5%	27.8%	30.0%	29.3%	27.3%	28.3%	20.2%	26.3%	28.9%	27.8%	2.8%	10.0%
Sweden	35.4%	37.9%	33.9%	34.7%	37.9%	44.7%	34.9%	34.4%	39.4%	34.9%	47.0%	37.7%	4.4%	11.6%
United Kingdom	39.0%	34.7%	41.9%	40.5%	35.2%	34.7%	38.2%	41.4%	50.3%	41.7%	39.1%	39.7%	4.4%	11.2%
United States	32.1%	31.7%	32.8%	32.1%	31.7%	32.0%	33.3%	32.7%	32.9%	32.9%	32.1%	32.4%	0.5%	1.7%
average	40.1%	39.8%	40.6%	42.1%	41.4%	40.9%	40.3%	39.3%	43.2%	41.3%	42.4%	41.0%	1.2%	2.9%
Standard dev.	10.6%	10.2%	9.9%	10.5%	10.0%	10.4%	9.6%	11.4%	9.9%	8.5%	9.3%	10.0%		
Stdev./avg.	26.3%	25.6%	24.5%	25.1%	24.2%	25.3%	23.8%	29.2%	23.0%	20.7%	22.0%	24.5%		

Sources: OECD Taxing wage database and authors´ calculations

Table (4): Effective Marginal Energy Tax Rates

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	14.4%	14.8%	15.5%	16.4%	14.7%	16.0%	19.7%	14.9%	15.7%	16.3%	15.7%	15.8%	1.4%	9.1%
Belgium	7.3%	7.3%	8.2%	7.2%	8.1%	10.5%	8.4%	8.1%	8.6%	8.5%	18.6%	9.2%	3.3%	35.6%
Czech republic	1.0%	0.7%	0.9%	1.5%	1.1%	1.1%	2.0%	0.7%	1.6%	0.9%	3.7%	1.4%	0.9%	63.1%
Denmark	32.5%	26.3%	24.2%	35.6%	28.9%	29.0%	32.0%	27.7%	22.1%	30.8%	23.5%	28.4%	4.2%	14.7%
Finland	8.0%	8.1%	7.6%	18.4%	19.4%	10.0%	12.9%	7.0%	11.2%	17.5%	14.2%	12.2%	4.6%	37.7%
France	7.5%	8.0%	8.5%	8.7%	8.7%	9.9%	8.9%	7.7%	13.4%	8.6%	9.9%	9.1%	1.6%	18.1%
Germany	9.5%	8.1%	8.8%	13.7%	9.9%	21.0%	16.6%	11.2%	11.1%	15.9%	10.5%	12.4%	4.0%	32.2%
Hungary	1.8%	1.1%	1.6%	2.5%	1.3%	1.4%	1.6%	1.3%	1.1%	1.1%	1.3%	1.5%	0.4%	28.0%
Ireland	7.6%	4.0%	3.0%	10.9%	7.1%	5.0%	9.0%	5.2%	4.3%	16.2%	2.9%	6.8%	4.0%	58.5%
Italy	20.4%	20.1%	21.0%	19.4%	22.0%	21.2%	20.5%	20.4%	22.0%	20.8%	22.0%	20.9%	0.9%	4.1%
Japan	7.5%	8.6%	8.8%	8.4%		8.2%	15.4%	7.7%			15.7%	10.0%	3.4%	34.3%
Netherlands	9.3%	9.1%	11.5%	9.3%	12.4%	11.0%	9.7%	10.1%	11.3%	9.5%	12.8%	10.5%	1.3%	12.6%
Portugal	1.8%	2.8%	2.6%	4.5%	2.4%	3.2%	8.0%	1.7%	6.2%	1.8%	2.1%	3.4%	2.1%	61.2%
Spain	5.4%	5.6%	6.3%	4.9%	10.4%	6.8%	11.0%	5.6%	7.2%	10.7%	8.8%	7.5%	2.3%	30.6%
Sweden	13.3%	8.7%	4.4%	26.9%	9.3%	20.1%	16.3%	7.7%	8.2%	18.2%	12.1%	13.2%	6.6%	50.2%
United Kingdom	5.2%	8.3%	8.0%	17.0%	14.2%	10.3%	14.2%	6.6%	54.8%	17.6%	35.8%	17.5%	15.0%	85.8%
United States	1.7%	2.8%	1.0%	6.4%	1.4%	1.5%	3.2%	2.4%	8.2%	1.4%	2.1%	2.9%	2.3%	78.6%
average	9.1%	8.5%	8.3%	12.5%	10.7%	11.0%	12.3%	8.6%	12.9%	12.2%	12.4%	10.8%	1.8%	17.1%
Standard dev.	7.9%	6.6%	6.7%	9.1%	7.9%	8.1%	7.6%	7.0%	12.7%	8.4%	9.2%	8.3%		
Stdev./avg.	86.8%	78.1%	79.9%	72.8%	73.5%	73.7%	61.7%	81.6%	98.1%	69.0%	73.9%	76.9%		

Sources: IEA and authors´ calculations

Table (5): Tax incidence and mark-up parameters used to calculate the effective marginal tax rate on total production cost.

	Tax incidence on labour (employers payroll taxes)	**Tax incidence on labour (employee – taxes & benefits)**	**Tax incidence on capital**	**Tax incidence on energy**	**Mark-up on final prices**
Baseline	$\beta_l^{er} = 1$	$\beta_l^{ee} = 0.33$	$\beta_k = 1$	$\beta_e = 1$	$\mu = 0$
Scenario 1:	$\beta_l^{er} = 0.5$	$\beta_l^{ee} = 0.33$	$\beta_k = 1$	$\beta_e = 1$	$\mu = 0$
Scenario 2:	$\beta_l^{er} = 1$	$\beta_l^{ee} = 0$	$\beta_k = 1$	$\beta_e = 1$	$\mu = 0$
Scenario 3:	$\beta_l^{er} = 1$	$\beta_l^{ee} = 0.33$	$\beta_k = 0.5$	$\beta_e = 1$	$\mu = 0$
Scenario 4:	$\beta_l^{er} = 1$	$\beta_l^{ee} = 0.33$	$\beta_k = 1$	$\beta_e = 0.5$	$\mu = 0$
Scenario 5:	$\beta_l^{er} = 1$	$\beta_l^{ee} = 0.33$	$\beta_k = 1$	$\beta_e = 1$	$\mu \geq 0$ in sector/country specific estimates

Table (6): Effective Marginal Tax Rates on Total Production Cost : country-results and differences across scenarios

country	*Baseline*	*Scenario 1 Partial payroll taxes*	*Scenario 2 No wage taxes*	*Scenario 3 Partial capital taxes*	*Scenario 4 Partial energy taxes*	*Scenario 5 Mark-ups in final product price*	*Baseline vs. S1*	*Baseline vs. S2*	*Baseline vs. S3*	*Baseline vs. S4*	*Basline vs. S5*
Austria	36.5%	26.3%	25.7%	34.4%	35.8%	--	-10.2%	-10.8%	-2.1%	-0.6%	--
Belgium	32.0%	22.5%	20.7%	32.4%	31.4%	21.5%	-9.5%	-11.3%	0.4%	-0.7%	-10.5%
Czech republic	28.0%	18.9%	22.4%	26.5%	27.9%	--	-9.2%	-5.7%	-1.6%	-0.1%	--
Denmark	18.7%	18.7%	4.3%	17.3%	17.8%	16.5%	0.0%	-14.5%	-1.5%	-0.9%	-2.2%
Finland	31.9%	23.6%	20.6%	30.6%	31.3%	26.2%	-8.3%	-11.3%	-1.4%	-0.6%	-5.7%
France	41.3%	27.9%	34.5%	38.0%	40.8%	31.7%	-13.4%	-6.9%	-3.4%	-0.6%	-9.6%
Germany	31.5%	24.2%	18.9%	29.6%	30.9%	27.4%	-7.2%	-12.6%	-1.8%	-0.5%	-4.1%
Hungary	34.4%	25.0%	24.5%	31.9%	34.3%	--	-9.4%	-9.9%	-2.5%	-0.1%	--
Ireland	16.8%	13.2%	10.0%	15.6%	16.6%	--	-3.6%	-6.8%	-1.2%	-0.2%	--
Italy	34.8%	25.4%	26.7%	32.4%	33.2%	27.0%	-9.4%	-8.1%	-2.4%	-1.6%	-7.8%
Japan	24.1%	19.6%	17.2%	20.5%	23.5%	19.1%	-4.5%	-6.9%	-3.6%	-0.6%	-5.0%
Netherlands	18.7%	15.2%	11.3%	17.1%	18.0%	3.9%	-3.5%	-7.4%	-1.6%	-0.7%	-14.8%
Portugal	25.2%	18.6%	18.4%	23.0%	24.9%	--	-6.7%	-6.8%	-2.2%	-0.3%	--
Spain	32.1%	23.0%	26.5%	28.2%	31.6%	--	-9.1%	-5.6%	-3.9%	-0.5%	--
Sweden	34.9%	24.0%	26.0%	33.5%	34.3%	12.3%	-10.9%	-8.9%	-1.4%	-0.6%	-22.6%
United Kingdom	21.9%	18.2%	13.3%	19.4%	21.3%	11.9%	-3.7%	-8.6%	-2.5%	-0.6%	-10.0%
United States	20.0%	16.7%	12.0%	17.4%	19.8%	18.6%	-3.3%	-8.0%	-2.6%	-0.2%	-1.3%

Table (7): Effective Marginal Tax rates on total production cost: sector composition effects

Country	*(1) Baseline weighted average EMTR*	*(2) Unweighted baseline average EMTR*	*Dif (1) - (2)*
Austria	36.5%	35.6%	-0.9%
Belgium	32.0%	32.3%	0.3%
Czech republic	28.0%	26.6%	-1.4%
Denmark	18.7%	19.1%	0.3%
Finland	31.9%	31.5%	-0.5%
France	41.3%	40.7%	-0.6%
Germany	31.5%	30.5%	-1.0%
Hungary	34.4%	33.3%	-1.1%
Ireland	16.8%	17.6%	0.8%
Italy	34.8%	33.3%	-1.5%
Japan	24.1%	23.4%	-0.7%
Netherlands	18.7%	19.1%	0.4%
Portugal	25.2%	24.3%	-1.0%
Spain	32.1%	31.2%	-0.9%
Sweden	34.9%	33.6%	-1.4%
United Kingdom	21.9%	22.2%	0.2%
United States	20.0%	19.0%	-1.0%

Table (8) Effective marginal tax rates on labour and energy after a tax shift

	Baseline		50% employer tax reduction		100% employer tax reduction	
	*labour tax**	*Energy tax*	*Labour tax**	*Energy tax*	*Labour tax**	*Energy tax*
Austria	43%	16%	29%	220%	15%	425%
Belgium	49%	9%	33%	144%	18%	279%
Czech Republic	46%	1%	28%	102%	11%	202%
Denmark	19%	28%	19%	28%	19%	28%
Finland	40%	12%	28%	137%	16%	261%
France	53%	9%	32%	242%	11%	474%
Germany	36%	12%	26%	134%	16%	256%
Hungary	53%	1%	35%	140%	18%	278%
Ireland	22%	7%	17%	63%	12%	119%
Italy	47%	21%	30%	103%	14%	185%
Japan	23%	10%	16%	45%	10%	79%
Netherlands	22%	11%	17%	70%	12%	129%
Portugal	36%	3%	24%	71%	12%	138%
Spain	39%	8%	24%	111%	9%	215%
Sweden	45%	13%	29%	219%	12%	424%
United Kingdom	23%	15%	18%	59%	13%	103%
United States	20%	3%	15%	43%	11%	82%
Total	37%	11%	26%	119%	14%	228%

*Note: * The effective marginal tax rate on labour includes both employees and employer taxes***.** *The tax shift simulates the impact on the effective marginal cost on total production cost of successive reduction (from 5% to 100%) of the tax paid by employers which is compensated by an increase in the effective tax on energy product so as to leave the total tax revenues collected unchanged.*

Appendix

Table (A1): Relative hourly wages in the manufacturing industry (ratio between sector and average manufacturing wages for 2000-2011)

country	Iron & Steel	Chemical and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food & tobacco	Paper, pulp & print	Wood and wood products	Textile & leather	Other industries	STD Dev.
Austria	1.08	1.07	1.10	0.94	1.21	1.26	0.82	1.04	0.75	0.75	0.97	0.17
Belgium	1.16	1.16	1.07	0.88	1.36	1.23	0.80	0.90	0.71	0.73	1.01	0.21
Czech rep.	N/A	1.23	1.15	1.04	N/A	N/A	0.97	1.05	0.79	0.78	N/A	0.17
Germany	1.03	1.30	1.08	0.82	1.41	1.26	0.68	0.89	0.72	0.75	1.05	0.25
Denmark	0.99	1.24	0.96	0.89	1.02	1.09	0.88	1.04	0.92	0.96	1.00	0.10
Greece	0.95	1.27	1.02	1.22	1.21	0.99	0.90	0.90	0.93	0.75	0.84	0.17
Spain	1.06	1.25	1.12	0.87	1.34	1.19	0.77	0.97	0.63	0.66	1.14	0.24
Finland	N/A	1.13	1.14	0.88	N/A	N/A	0.92	1.31	0.82	0.81	N/A	0.19
France	1.05	1.26	1.03	0.91	1.28	1.36	0.75	0.92	0.70	0.73	1.01	0.23
Hungary	0.98	1.53	1.22	1.00	1.23	1.09	0.80	1.09	0.60	0.59	0.87	0.28
Ireland	0.99	1.22	0.89	0.92	N/A	1.36	0.98	1.01	0.73	0.80	1.10	0.19
Italy	1.06	1.26	0.98	0.91	1.20	1.25	0.91	0.91	0.71	0.77	1.03	0.18
Japan	1.10	1.39	1.29	0.98	1.22	N/A	0.75	0.97	0.75	0.74	0.83	0.24
Netherl.	0.91	1.38	1.13	0.95	0.95	1.10	0.99	1.03	0.80	0.88	0.89	0.16
Poland	1.18	1.25	1.07	0.92	1.28	1.21	0.79	0.96	0.65	0.61	1.08	0.24
Portugal	1.17	1.45	N/A	0.98	N/A	N/A	0.87	N/A	0.66	0.87	N/A	0.27

Source: U.S. Bureau of Labour Statistics and authors´calculations

Table (A2): Wage differentials according to individual and firm-characteristics

country	*higher education*	*Gender*	*Interaction Higher education X gender*	*Firm size*
Austria	43.3%	-16.0%	-14.4%	4.4%
Belgium	33.4%	-5.6%	-2.4%	4.9%
Czech rep.	40.4%	-14.4%	1.9%	4.0%
Denmark	38.7%	-8.0%	-3.3%	2.7%
Finland	42.4%	-12.1%	-6.5%	4.5%
France	46.2%	-7.3%	-1.0%	4.1%
Germany	38.3%	-13.7%	2.3%	6.2%
Hungary	47.7%	-10.1%	-1.1%	4.0%
Ireland	43.4%	-13.6%	8.6%	4.1%
Italy	41.1%	-11.4%	-8.3%	3.1%
Japan	40.3%	-14.3%	2.8%	4.0%
Luxembourg	42.4%	-8.3%	-2.3%	4.1%
Netherlands	34.8%	-13.1%	3.0%	2.2%
Poland	30.6%	-30.9%	30.7%	4.1%
Portugal	50.5%	-27.9%	14.8%	4.4%
Spain	23.4%	-27.9%	7.9%	5.4%
Sweden	26.0%	-5.0%	-4.6%	2.5%
United Kingdom	50.2%	-12.2%	3.8%	4.1%
United States	65.0%	-18.6%	-1.1%	3.7%

Source: Strauss and de la Maisonneuve (2009).

Table (A3): List of energy sources and Carbon Emissions Factors (CEF)

Code	English Desc	Emission rate (ton CO2/tJ)
HARDCOAL	Hard coal (if no detail)	20
BROWN	Brown coal (if no detail)	26.6
ANTCOAL	Anthracite	26.8
COKCOAL	Coking coal	25.8
BITCOAL	Other bituminous coal	25.8
SUBCOAL	Sub-bituminous coal	26.2
LIGNITE	Lignite	27.6
PATFUEL	Patent fuel	26.6
OVENCOKE	Coke oven coke	29.2
GASCOKE	Gas coke	29.2
COALTAR	Coal tar	22
BKB	BKB/peat briquettes	25.8
GASWKSGS	Gas works gas	12.1
COKEOVGS	Coke oven gas	12.1
BLFURGS	Blast furnace gas	70.8
OXYSTGS	Other recovered gases	49.6
PEAT	Peat	28.9
NATGAS	Natural Gas	15.3
CRNGFEED	Crude/NGL/feedstocks (if no detail)	20
CRUDEOIL	Crude oil	20
NGL	Natural gas liquids	17.5
REFFEEDS	Refinery feedstocks	20
ADDITIVE	Additives/blending components	20
NONCRUDE	Other hydrocarbons	20
REFINGAS	Refinery gas	15.7
ETHANE	Ethane	16.8
LPG	Liquefied petroleum gases (LPG)	17.2
MOTORGAS	Motor gasoline	18.9
AVGAS	Aviation gasoline	19.1
JETGAS	Gasoline type jet fuel	19.1
JETKERO	Kerosene type jet fuel	19.5
OTHKERO	Other Kerosene	19.6
GASDIES	Gas/diesel oil	20.2
RESFUEL	Fuel oil	21.1
NAPHTHA	Naphtha	20
WHITESP	White spirit & SBP	20
LUBRIC	Lubricants	20
BITUMEN	Bitumen	22
PARWAX	Paraffin waxes	20
PETCOKE	Petroleum coke	26.6
ONONSPEC	Non-specified oil products	20
INDWASTE	Industrial waste	39
MUNWASTER	Municipal waste (renewable)	25
MUNWASTEN	Municipal waste (non-renewable)	27.3
SBIOMASS	Primary solid biofuels	29.9
GBIOMASS	Biogases	30.6
BIOGASOL	Biogasoline	19.3
BIODIESEL	Biodiesels	19.3
OBIOLIQ	Other liquid biofuels	21.7
RENEWNS	Non-specified primary biofuels and waste	20
CHARCOAL	Charcoal	30.5
MANGAS	Elec/heat output from non-specified manufactured gases	20
HEATNS	Heat output from non-specified combustible fuels	20
NUCLEAR	Nuclear	0
HYDRO	Hydro	0
GEOTHERM	Geothermal	0
SOLARPV	Solar photovoltaics	0
SOLARTH	Solar thermal	0
TIDE	Tide, wave and ocean	0
WIND	Wind	0
OTHER	Other sources	0
ELECTR	Electricity	10
HEAT	Heat	20

Source: IEA (2012a)

Table (A4): Matching between End-Use prices and Energy sources prices and taxes

Energy source code	Energy source description	Assignment
HARDCOAL	Hard coal (if no detail)	(L)
BROWN	Brown coal (if no detail)	(L)
ANTCOAL	Anthracite	(L)
COKCOAL	Coking coal	(M)
BITCOAL	Other bituminous coal	(L)
SUBCOAL	Sub-bituminous coal	(L)
LIGNITE	Lignite	(L)
PATFUEL	Patent fuel	avg(A;B)
GASCOKE	Gas coke	(K)
GASWKSGS	Gas works gas	(K)
COKEOVGS	Coke oven gas	(K)
BLFURGS	Blast furnace gas	(K)
OXYSTGS	Other recovered gases	(K)
NATGAS	Natural Gas	(K)
CRNGFEED	Crude/NGL/feedstocks (if no detail)	(K)
CRUDEOIL	Crude oil	(C)
NGL	Natural gas liquids	(K)
REFFEEDS	Refinery feedstocks	(K)
REFINGAS	Refinery gas	(K)
ETHANE	Ethane	(K)
LPG	Liquefied petroleum gases (LPG)	(J)
MOTORGAS	Motor gasoline	avg(E;F;G;H)
GASDIES	Gas/diesel oil	(D)
RESFUEL	Fuel oil	avg(A;B)
CHARCOAL	Charcoal	(L)
MANGAS	Elec/heat output from non-specified manufactured gases	(N)
ELECTR	Electricity	(N)

Source: IEA (2012b).

Legend: (A) High sulphur fuel oil (B) Low sulphur fuel oil (C) Light fuel oil (D) Automotive diesel (E) Premium leaded gasoline (F) Regular leaded gasoline (G) Premium unleaded 95 RON (H) Premium unleaded 98 RON (I) Regular unleaded gasoline (J) Liquefied petroleum gas (K) Natural gas (L) Steam coal (M) Coking coal (N) Electricity.

Table (A5): Capital inputs weights, average 2001-2010

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	18.3%	22.5%	16.8%	19.7%	21.8%	15.5%	19.9%	21.3%	21.0%	11.6%	12.3%	18.3%	3.8%	20.6%
Belgium	18.3%	20.9%	16.8%	19.8%	16.9%	13.6%	23.6%	24.2%	23.1%	14.6%	14.2%	18.7%	3.9%	20.6%
Czech republic	18.3%	32.9%	16.8%	25.3%	38.5%	26.6%	30.8%	30.5%	32.1%	18.7%	17.1%	26.2%	7.5%	28.6%
Denmark	16.9%	23.6%	15.6%	18.6%	13.8%	15.3%	21.8%	17.6%	14.1%	15.2%	14.7%	17.0%	3.2%	18.7%
Finland	23.0%	18.4%	16.8%	15.2%	9.1%	13.6%	19.9%	16.8%	16.6%	8.0%	7.9%	15.0%	4.9%	32.8%
France	18.3%	24.2%	16.8%	19.4%	23.0%	17.2%	22.8%	21.8%	19.9%	12.9%	13.5%	19.1%	3.8%	19.8%
Germany	13.9%	17.3%	13.8%	14.0%	17.9%	13.0%	15.5%	16.1%	13.1%	10.4%	8.4%	13.9%	2.8%	20.1%
Hungary	18.7%	37.7%	21.2%	30.2%	43.4%	26.1%	24.4%	30.0%	23.7%	11.2%	22.3%	26.3%	8.9%	33.9%
Ireland	18.7%	24.3%	16.8%	19.4%	22.8%	17.3%	22.8%	21.8%	19.9%	13.0%	13.6%	19.1%	3.7%	19.5%
Italy	18.3%	29.5%	16.8%	24.6%	32.6%	19.9%	33.5%	26.4%	26.3%	17.4%	19.3%	24.1%	6.1%	25.4%
Japan	18.0%	23.2%	15.5%	18.9%		16.4%	21.7%	19.7%			13.1%	18.3%	3.3%	18.0%
Netherlands	18.3%	20.0%	16.8%	12.7%	13.8%	15.1%	20.7%	17.9%	13.5%	12.1%	8.6%	15.4%	3.7%	24.1%
Portugal	18.3%	24.2%	16.8%	19.4%	23.0%	17.2%	22.8%	21.8%	19.9%	12.9%	13.5%	19.1%	3.8%	19.8%
Spain	18.3%	24.2%	16.8%	19.4%	23.0%	17.2%	22.8%	21.8%	19.9%	12.9%	13.5%	19.1%	3.8%	19.8%
Sweden	19.9%	22.6%	16.9%	17.2%	25.7%	13.6%	19.9%	20.9%	21.0%	12.6%	12.0%	18.4%	4.4%	23.7%
United Kingdom	18.3%	24.2%	16.8%	19.4%	23.0%	17.2%	22.8%	21.8%	20.6%	12.9%	13.5%	19.2%	3.8%	19.8%
United States	16.4%	17.4%	15.2%	12.8%	14.0%	15.8%	16.9%	12.6%	8.8%	6.8%	10.0%	13.3%	3.5%	26.4%
average	18.3%	24.0%	16.7%	19.2%	22.7%	17.1%	22.5%	21.4%	19.6%	12.7%	13.4%	18.8%	3.7%	19.6%
Standard dev.	1.8%	5.3%	1.4%	4.5%	9.2%	3.9%	4.3%	4.7%	5.6%	3.0%	3.7%	4.3%		
Stdev./avg.	9.6%	22.1%	8.7%	23.3%	40.5%	22.9%	19.3%	21.8%	28.5%	23.6%	27.9%	22.9%		

Table (A6): Labour inputs weights, average 2001-2010

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	56.3%	72.1%	59.6%	71.0%	75.5%	81.3%	74.9%	62.3%	70.4%	82.8%	80.2%	71.5%	8.9%	12.4%
Belgium	56.3%	66.1%	59.6%	65.5%	79.9%	82.4%	67.2%	65.1%	65.8%	76.1%	58.3%	67.5%	8.6%	12.7%
Czech republic	56.3%	57.7%	59.6%	50.8%	56.5%	65.7%	58.2%	51.0%	60.5%	70.1%	55.4%	58.3%	5.7%	9.8%
Denmark	60.7%	73.0%	72.0%	66.8%	81.0%	80.7%	68.3%	74.6%	80.8%	78.7%	76.0%	73.9%	6.6%	8.9%
Finland	53.4%	70.5%	55.3%	72.6%	86.6%	83.8%	73.6%	48.6%	74.1%	86.9%	75.7%	71.0%	13.3%	18.7%
France	56.3%	66.1%	59.6%	63.3%	73.2%	78.3%	68.0%	61.1%	71.6%	80.1%	70.2%	68.0%	7.6%	11.2%
Germany	59.5%	74.3%	64.1%	68.4%	79.5%	84.9%	77.0%	68.5%	79.8%	83.3%	73.4%	73.9%	8.1%	10.9%
Hungary	49.1%	52.1%	49.1%	46.1%	52.0%	68.6%	63.9%	59.2%	68.8%	85.2%	64.7%	59.9%	11.7%	19.6%
Ireland	57.5%	66.1%	59.5%	63.2%	73.4%	78.3%	67.9%	61.0%	71.6%	80.0%	70.2%	68.1%	7.4%	10.9%
Italy	56.3%	61.0%	59.6%	51.4%	63.2%	69.9%	53.6%	54.4%	59.3%	74.0%	57.0%	60.0%	6.9%	11.5%
Japan	54.7%	65.9%	59.7%	62.0%		78.6%	67.8%	60.6%			70.3%	65.0%	7.4%	11.4%
Netherlands	56.3%	62.7%	59.6%	71.8%	82.8%	80.5%	68.3%	70.3%	82.4%	81.2%	84.7%	72.8%	10.2%	14.0%
Portugal	56.3%	66.1%	59.6%	63.3%	73.2%	78.3%	68.0%	61.1%	71.6%	80.1%	70.2%	68.0%	7.6%	11.2%
Spain	56.3%	66.1%	59.6%	63.3%	73.2%	78.3%	68.0%	61.1%	71.6%	80.1%	70.2%	68.0%	7.6%	11.2%
Sweden	58.1%	70.6%	59.8%	68.5%	71.9%	84.4%	72.7%	51.6%	72.1%	81.5%	69.3%	69.1%	9.7%	14.0%
United Kingdom	56.3%	66.1%	59.6%	63.3%	73.2%	78.3%	68.0%	61.1%	73.2%	80.1%	70.2%	68.1%	7.7%	11.3%
United States	56.2%	67.7%	55.0%	61.7%	82.5%	80.4%	71.8%	70.6%	73.5%	82.6%	85.6%	71.6%	10.7%	15.0%
average	56.2%	66.1%	59.5%	63.1%	73.6%	78.4%	68.1%	61.3%	71.7%	80.2%	70.7%	68.1%	7.7%	11.3%
Standard dev.	2.5%	5.6%	4.5%	7.4%	9.4%	5.5%	5.7%	7.2%	6.3%	4.1%	8.6%	6.1%		
Stdev./avg.	4.4%	8.4%	7.6%	11.8%	12.8%	7.0%	8.4%	11.7%	8.8%	5.1%	12.2%	8.9%		

Table (A7): Energy inputs weights, average 2001-2010

	Iron and Steel	Chemicals and petrochemical	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Food and tobacco	Paper, pulp and print	Wood and wood products	Textile and leather	Other manuf. Industries	average	Standard dev.	Stdev./avg.
Austria	25.4%	5.4%	23.6%	9.3%	2.7%	3.2%	5.2%	16.5%	8.5%	5.6%	7.5%	10.2%	8.0%	77.7%
Belgium	25.4%	13.0%	23.6%	14.8%	3.2%	3.9%	9.2%	10.7%	11.1%	9.3%	27.6%	13.8%	8.3%	60.2%
Czech republic	25.4%	9.4%	23.6%	23.9%	5.0%	7.6%	11.0%	18.5%	7.5%	11.2%	27.5%	15.5%	8.4%	53.8%
Denmark	22.4%	3.3%	12.5%	14.6%	5.2%	3.9%	9.9%	7.8%	5.1%	6.1%	9.3%	9.1%	5.7%	62.3%
Finland	23.6%	11.1%	27.9%	12.2%	4.3%	2.5%	6.5%	34.6%	9.3%	5.1%	16.4%	14.0%	10.5%	75.5%
France	25.4%	9.6%	23.6%	17.3%	3.7%	4.4%	9.3%	17.1%	8.5%	7.0%	16.2%	12.9%	7.4%	57.5%
Germany	26.6%	8.4%	22.0%	17.6%	2.6%	2.1%	7.6%	15.4%	7.1%	6.2%	18.2%	12.2%	8.2%	67.2%
Hungary	32.2%	10.2%	29.7%	23.7%	4.6%	5.3%	11.8%	10.8%	7.5%	3.7%	13.1%	13.9%	10.1%	72.8%
Ireland	23.8%	9.7%	23.6%	17.4%	3.7%	4.4%	9.3%	17.2%	8.5%	7.0%	16.3%	12.8%	7.2%	56.0%
Italy	25.4%	9.5%	23.6%	24.0%	4.2%	10.2%	12.9%	19.2%	14.4%	8.6%	23.7%	16.0%	7.5%	46.9%
Japan	27.3%	10.9%	24.8%	19.0%		5.1%	10.5%	19.7%			16.5%	16.7%	7.6%	45.2%
Netherlands	25.4%	17.3%	23.6%	15.5%	3.4%	4.3%	11.0%	11.8%	4.1%	6.7%	6.7%	11.8%	7.8%	65.9%
Portugal	25.4%	9.6%	23.6%	17.3%	3.7%	4.4%	9.3%	17.1%	8.5%	7.0%	16.2%	12.9%	7.4%	57.5%
Spain	25.4%	9.6%	23.6%	17.3%	3.7%	4.4%	9.3%	17.1%	8.5%	7.0%	16.2%	12.9%	7.4%	57.5%
Sweden	22.0%	6.8%	23.4%	14.3%	2.4%	2.0%	7.4%	27.5%	6.9%	5.9%	18.6%	12.5%	9.1%	72.7%
United Kingdom	25.4%	9.6%	23.6%	17.3%	3.7%	4.4%	9.3%	17.1%	6.2%	7.0%	16.2%	12.7%	7.6%	59.7%
United States	27.4%	14.9%	29.8%	25.5%	3.4%	3.8%	11.3%	16.8%	17.6%	10.6%	4.3%	15.0%	9.5%	63.0%
average	25.5%	9.9%	23.9%	17.7%	3.7%	4.5%	9.4%	17.3%	8.7%	7.1%	15.9%	13.1%	7.5%	57.2%
Standard dev.	2.3%	3.2%	3.7%	4.4%	0.8%	2.0%	2.0%	6.3%	3.3%	2.0%	6.6%	3.3%		
Stdev./avg.	8.8%	32.6%	15.5%	25.0%	21.5%	44.0%	20.8%	36.1%	38.3%	27.5%	41.1%	25.4%		

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KP-AC-14-045-EN-C

ISBN 978-92-79-38371-7

doi:10.2778/35372

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