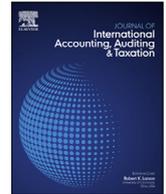


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Reducing tax compliance costs through corporate tax base harmonization in the European Union

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ABSTRACT

The aim of the Common Consolidated Corporate Tax Base (CCCTB) proposal made by the European Commission is to reduce both tax compliance costs and tax avoidance opportunities of cross-border operations within the European Union. However, to date the scarcity of comparable estimates of tax compliance costs has limited researchers' ability to assess the probable impact of this proposal. We exploit recently released unique survey data designed to provide comparable information on corporate tax compliance costs in order to assess the impact of the CCCTB, using a general equilibrium modeling approach. Our results suggest that the reduction in tax compliance costs would be associated with greater economic efficiency. Member states with the lowest compliance costs before the reform and those that have large inward foreign investment stock would benefit more than other member states. Cross-border business operations would also benefit more than domestic ones. The impact on non-EU countries, such as the US and Japan, would be limited.

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1. Introduction

Corporate tax avoidance through global profit shifting has become an economic activity in its own right. A large body of evidence (see in particular [Nicodème, 2009](#); [Riedel, 2018](#); [Van't Riet & Lejour, 2018](#)) suggests that global corporations exploit cross-border differences in corporate income tax rules. Such corporations take advantage of existing inconsistencies and loopholes within the international tax network through schemes such as transfer pricing, debt shifting, and the strategic allocation of intangible assets across tax jurisdictions. This is especially true in the European Union (EU), which is characterized by free capital mobility and fragmented tax policies. The EU member states set their own rules to define tax bases and tax rates, including tax rebates on certain types of economic activity and/or differential tax treatment of corporate income generated abroad. Under these circumstances, firms can see tax planning as an optimal response to the presence of multiple tax jurisdictions.

Global tax planning and corporate tax avoidance are costly activities, however. Firms operating across borders must deal with multiple tax jurisdictions and procedures that require local expertise. These activities impose extra private costs, e.g., paying foreign tax officials and local experts to obtain the information needed to deal with foreign tax systems. The costs related to audits, litigation, and transfer pricing planning are especially relevant for companies with subsidiaries in other EU countries ([European Commission, 2004](#)). Multinationals therefore face greater costs than firms that operate only in their

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own domestic market. These costs can be significant (see [Eichfelder & Vaillancourt, 2014](#) for an extensive review). Tax planning also entails broader economic and social costs. It may distort the allocation of resources (especially capital) and move the economy further away from the theoretical first-best allocation that would be obtained in a no-tax world, thereby harming production efficiency both globally and in the EU ([Huizinga & Laeven, 2008](#); [Alvarez-Martinez et al., 2018](#)). Tax planning also contributes to the growing social discontent about income inequality, with tax systems often perceived as giving global corporations an exorbitant advantage over other taxpayers (see [European Commission, 2015](#) and [Tørsløv, Wier, & Zucman, 2017](#) for recent evidence).

Tax compliance costs have long been considered a major hurdle for investments across EU countries, despite the high level of economic integration between them (see, for instance, [European Commission, 2001](#)). The European Commission has recently re-launched its Consolidated Common Corporate Tax Base (CCCTB) reform proposal aimed at reducing the cost of business operations at the EU level.¹ The proposal envisages two main reforms to be implemented in stages: the common corporate tax base (CCTB) and the common consolidated corporate tax base (CCCTB).² The first stage would involve a common tax base, introducing harmonized tax accounting rules for calculating the taxable profits of a company, e.g., with regard to amortization and depreciation periods, tax accounting methods for inventories, and R&D spending. The aim is to eliminate mismatches between national systems that aggressive tax planners often exploit and to reduce the administrative burden by having a single definition of the tax base. The second stage would consolidate reporting at the level of a multinational group via a formula apportionment reflecting the geographical distribution of the multinational's activities (taking into account the value of property, sales, and labor employed in each country). Consolidation implies that intra-group transactions would be ignored and the consolidated group profits would be apportioned by a formula to the jurisdictions where the corresponding economic activity took place. Cross-border companies would be able to offset losses in one member state against profits in another. Both reforms are expected to be mandatory only for multinational groups with total consolidated revenue of at least EUR 750 million.

This proposal was assessed by the European Commission services using the Computable General Equilibrium (CGE) model CORTAX, as described in detail in [Alvarez-Martinez et al. \(2016a\)](#). In the absence of reliable and comparable estimates for all EU countries, the assessment assumed identical levels and uniform (post-CCCTB) changes in tax compliance costs across countries. This represents a limitation of the previous analysis to the extent that the impact of the CCCTB is expected to be mediated by a reduction in tax compliance costs. The CCCTB is also likely to affect countries differently, depending among other things on their tax system and reliance on foreign direct investment. The aim of this paper is to overcome these limitations by exploiting a newly released dataset on tax compliance costs from a survey performed by KPMG for the EU Executive Agency for Small and Medium-sized Enterprises (EASME). These data can be used to calibrate country-specific tax compliance costs before and after the CCCTB. Using these data allows us to provide new insights and more dependable estimates of the economic impact of the CCCTB reform proposal under alternative scenarios for reducing tax compliance costs.

The decline in tax compliance costs resulting from the CCCTB proposal is likely to trigger reactions from companies and governments alike. Representing the complexity of these different reactions is far from an easy task. With the CCCTB, member states would still be able to compete to attract investment, but they would compete via tax rates (and thus, possibly, in a more transparent way; see [Mintz, 2004](#); [McLure, 2008](#)). Multinationals would have greater freedom to choose their headquarters location even more strategically. This could have implications for governments who could adjust their corporate income tax (CIT) rates depending on the changes (expected or realized) in cross-border investment flows, in order to retain or attract new investment, as in the analysis and simulation results presented in [Sørensen \(2004\)](#). The change in tax compliance costs stemming from the CCCTB could therefore affect investment, including cross-border investment, and could trigger further reactions from governments.³

In the accounting literature, most studies on the CCCTB focus on the consolidating element of the proposals, particularly the formula apportionment. Using a principal-agent framework, [Martini et al. \(2016\)](#) investigate the tax-induced distortions of managerial incentives and remuneration packages caused by including payroll as one of the apportionment factors in the formula apportionment. [Clausing and Lahav \(2011\)](#) use data on 50 large U.S. multinational firms to assess the revenue impact of formula apportionment. [Sundvik \(2017\)](#) sheds light on the effect of book-tax conformity on the complexity of implementing the CCCTB. [Martini et al. \(2012\)](#) find evidence of changing economic decisions following the implementation of formula apportionment.

The use of a CGE model such as CORTAX is warranted to account for the potential impacts and interactions that the adoption of the CCCTB would entail, both within and across countries. The CORTAX model is multi-country: it includes all EU member states, Japan, the UK, the US, and a tax haven. It differentiates between domestic and multinational firms and is calibrated taking into account cross-border foreign direct investment (FDI) stocks. The CORTAX model also captures the complexity of the corporate tax system, including the specific treatments of different classes of assets, which ultimately

¹ The CCCTB proposal is an ambitious plan aimed at making EU tax systems more transparent in order to fight profit shifting, enhance efficiency, and provide a level playing field across member states; see [European Commission \(2016\)](#). For more information, see https://ec.europa.eu/taxation_customs/business/company-tax/common-consolidated-corporate-tax-base-ccctb_en. A previous proposal was made in 2011; see [European Commission \(2011a\)](#).

² Throughout the paper, we refer to the CCCTB proposal as encompassing both stages of the reform.

³ The magnitude of these effects, however, is difficult to predict because the post-reform equilibrium tax rates will depend on specific countries' circumstances. For instance, [Pethig and Wagener \(2007\)](#) show that the (Nash) equilibrium CIT rates after a CCCTB reform are a function of the chosen formula apportionment rule, given that the different components of this formula (i.e., property, sales, and labor) have different elasticities with respect to the tax rate. Under the apportionment formula foreseen by the CCCTB proposal, property, sales, and labor are equally weighted. Our analysis does not deal with this specific question, but we acknowledge that this is a potentially important issue.

determine the corporate tax bases of multinationals and their affiliates across countries. It also accounts for the possibility of exploiting corporate tax rate differences through debt shifting and transfer pricing. In CORTAX, tax compliance costs are represented as a given percentage of the labor costs. This modeling choice seems natural, since one may think of tax compliance costs as effectively being represented by the services provided by specific types of workers (in-house or outsourced), such as lawyers, accountants, consultants, etc.

The present paper offers two main contributions. First, by employing country-specific estimates for tax compliance costs, we can evaluate the differential impact of the proposed reforms in a more precise way, especially when comparing our results against official estimates presented in the CCCTB proposal's Impact Assessment documentation. Our simulation results shed light on the linkages between tax compliance costs and the economic impact of the CCCTB proposal, depending on country-specific characteristics. To our knowledge, this is the first attempt to assess the effects of the CCCTB accounting for both heterogeneous compliance costs and general-equilibrium macroeconomic effects. Second, our simulations of the CCTB (which unlike the CCCTB would harmonize tax bases without introducing revenue apportioning) provide evidence, within a general-equilibrium framework, of the mediating role of tax compliance costs. In particular, we determine that the economic effects of a change in the tax accounting rules used for defining national corporate tax bases (in terms of aggregate investment, labor market outcomes, and welfare) are also a function of the assumed levels of initial and post-reform tax compliance costs.

Our analysis suggests that changes in tax compliance costs caused by the harmonization of corporate tax bases would have a significant and positive impact on gross domestic product (GDP) and welfare. We illustrate the mechanisms through which these changes would occur depending on the starting levels and differences in tax compliance costs. Variations in compliance costs would directly affect labor demand since compliance costs are represented by the amount of labor involved in tax compliance activities. Therefore, the CCCTB would also indirectly impact the demand for capital and the overall production in the economy. In addition, the incentive to supply labor would be altered by changes in wages and thus affect welfare. When assuming budget neutrality, we find that on average, the CCCTB would yield a slight increase in the corporate income tax (CIT) rates in the EU, marginally affecting the incentives for firms to shift profits across borders. Our simulations suggest, perhaps counterintuitively, that countries that had relatively lower tax compliance costs before the reform (e.g., Luxembourg, the Netherlands, and Spain) would benefit more from the CCCTB. These countries would therefore gain relatively more from the consolidated corporate tax base. Furthermore, countries that hosted more foreign investment before the reform (i.e., countries with a large FDI stock, such as Denmark, Luxembourg, and Malta) would reap extra benefits from the CCCTB as well. We also find that the CCCTB would favor multinationals over domestic firms. This result suggests that domestic firms that are willing to operate across EU borders may also benefit from the reform. The effects of the CCCTB on non-EU countries are found to be negligible.

The rest of the paper is organized as follows. [Section 2](#) summarizes the CCCTB proposal and further explains the contribution of the present paper in relation to it and the relevant literature. [Section 3](#) briefly presents the main characteristics of CORTAX and describes the modeling of tax compliance costs. [Section 4](#) describes the data used for modeling tax compliance costs. [Section 5](#) presents the CCCTB simulations and discusses the results. [Section 6](#) concludes.

2. The European context and the CCCTB proposal

The fragmented European corporate tax system imposes a burden on corporate groups that operate across EU countries and must comply with different national tax systems. [Martens-Weiner \(2006\)](#) shows that companies doing business across EU member states face higher compliance costs than those doing business only locally. The recent re-launch of the proposal to harmonize and consolidate corporate tax bases in the EU highlights the potential benefits of such a measure, which could reduce the cost of tax operations while making national corporate systems more transparent ([European Commission, 2016](#)).

The expected benefits of corporate tax base harmonization in the EU have long been debated. [Mintz \(2004\)](#) sees the reduction of compliance and administrative burdens as the ultimate aim of corporate tax base harmonization and consolidation. He discusses previous CCCTB reform proposals for the EU (which were similar in spirit to the 2016 proposal) and envisages its compulsory implementation as the optimal solution. [Evans \(2003\)](#) calls for tax law design to account for the impact of the proposed changes on the operating costs of the tax system. The proposed design would mimic the Canadian system which, according to the author, achieved considerable savings in administrative and compliance costs. [McLure \(2008\)](#) discusses the issues related to the multiplicity of corporate tax systems in the EU and the implications of harmonization, finding a rationale for harmonization in the drawbacks of the currently fragmented EU tax system, which features separate accounting and lack of uniformity in arm's-length pricing standards, among other problems. Corporate tax base harmonization and consolidation may therefore significantly reduce compliance and administration costs.

A [PwC \(2008\)](#) survey on multinationals provides estimates of the potential impact of the CCCTB on tax compliance costs, confirming a reduction in these costs. PwC's study was commissioned for the European Commission's Impact Assessment (IA) of the 2011 CCCTB ([European Commission, 2011b](#)). The study quantifies one-off costs expected to arise once the common tax base is implemented, such as training staff, calculations to set up an asset pool for tax depreciation under the common regime, development of new processes and systems, consulting/advisory fees, software license fees, and outsourcing compliance cost obligations. Also, as the reform would be mandatory for multinationals only, costs may arise from implementing two parallel tax systems. The respondents predicted, on average, an increase of 4% in overall time spent on corpo-

rate tax compliance activities in the event of a common base. However, such costs are expected to be outweighed by the savings in recurring outlays that companies face in dealing with different tax administrations. Regarding the shift to a CCCTB system, the survey participants predicted, on average, an 8% reduction in overall time spent on corporate income tax compliance activities, mainly due to savings in transfer pricing documentation. The 2011 IA also relied on an expert assessment conducted by Deloitte, which focuses on the time and compliance cost of setting up a new subsidiary. The study estimates that the introduction of the CCTB would on average save approximately 10% in compliance time and about 2.5% in compliance costs. The main corporate compliance cost drivers that are directly or indirectly related to transfer pricing, which account for about 60% of all compliance costs, would remain unchanged. According to the IA, under the CCCTB, a 70% average decrease in total compliance time can be expected. Concerning tax administration, the IA highlights that there are no readily available data. In this paper, we rely on the 2011 IA findings when setting assumptions on the expected reduction in compliance and administrative costs.

To analyze the expected impact of the CCCTB, we must consider many interactions, including those between labor and capital markets, between countries, and between firm types (i.e., domestic and multinational). The effects of these interactions might differ across countries and generate potential winners and losers, at least in relative terms, given that capital mobility makes countries compete to attract corporate investment. As capital will likely move more easily across borders, this might also affect the composition of labor versus capital income as well as firms' investment strategies. Last but not least, governments may react to the CCCTB by changing their tax rates to compensate for potential budgetary losses. Resulting changes in the CIT rates across member states would, in turn, affect incentives to shift profits within the EU and to tax havens (see, for example, [Devereux et al., 2002](#); [Clausing, 2003](#); [Simmons, 2006](#)). Indeed, [Haga et al. \(2019\)](#) examine the cost behavior of companies that experience a tax reduction and find empirical evidence for income-decreasing cost behavior before tax rate cuts. In the following sections, we explain why a CGE model such as CORTAX is the appropriate methodology to carry out the analysis in a way that accounts for the most relevant interactions mentioned here.

3. Modeling tax compliance costs using the general equilibrium model CORTAX

3.1. A summary description of the CORTAX model

To perform our analysis, we use CORTAX, a computable general equilibrium model designed to investigate corporate tax reforms in the EU and used in the impact assessment of the CCCTB proposals (see [Alvarez-Martinez et al., 2016a, 2016b](#); [Bettendorf, Devereux, van der Horst, Loretz, & de Mooij, 2010](#)). In this section, we briefly describe the model. A more detailed mathematical description is provided by the aforementioned authors and in Appendix B. The CORTAX model covers all EU member states, Japan, the UK, the US, and a tax haven. It captures key features of corporate tax regimes, including the impact on the cost of capital and on investment decisions, assets depreciation and amortization rules, loss carry forward and loss compensation rules, profit shifting (both across non-haven countries and to a tax haven), debt-equity financing, and different deductibles for financial costs. The model encapsulates the behavior of all economic agents—households, firms, and governments—reflecting both the direct and indirect effects of policy changes on macroeconomic variables such as GDP, investment, and employment. Three firm categories are modeled: multinationals' headquarters, their subsidiaries located abroad, and domestic firms that produce only in their country of residence. Each country has one representative domestic firm, one multinational headquarters, and several subsidiaries that are owned by headquarters in other countries.⁴ Both domestic and multinational firms may shift profits to a tax haven to reduce their tax liability via debt shifting. Only multinationals, however, can also optimize their profit reporting across countries through transfer pricing via intra-firm trade in intermediate goods.⁵ Profit shifting is driven by CIT rate differentials (here tax rates are used as a proxy for marginal tax rates). The sensitivity of profit shifting to tax rate differentials is set to be the same across country pairs. There is an incentive for firms to shift profits from high to low tax countries and to minimize the overall tax burden. Organizational costs associated with the manipulation of transfer prices are specified using convex function, which makes profit shifting increasingly costly at the margin. We capture changes in incentives to profit shifting across countries under the different tax regimes, most importantly how these incentives would be modified under the common tax base. As tax avoidance lowers the effective corporate tax rate paid in a country, this also affects the cost of capital, which in turn drives investment choices. Thus, foreign investment is made sensitive to income-shifting opportunities as well as to countries' statutory tax rules.

Countries are linked to each other via international trade in goods markets and investment by multinationals. Each firm maximizes its value, equal to the net present value of all future cash flows, subject to the possibilities of the production function and accumulation constraints on physical capital and fiscal depreciation. The production function is a Cobb Douglas combination of a fixed factor and the value added, which, in turn, is an aggregate of labor and capital using a constant elasticity of substitution (CES) function. Labor is immobile across borders, and wages are determined in national labor markets. Capital is assumed to be perfectly mobile internationally so that the return to capital (after corporate taxes) is determined for

⁴ The number of firms is not modeled in CORTAX. This simplification still allows us to interpret the results of the policy simulations by comparing the situations of multinational enterprises and domestic firms. Yet the relative importance of domestic versus foreign firms is represented by the contribution of FDI stock to the total capital stock.

⁵ This modeling strategy arises naturally from the definition of multinational firms, which exchange intermediate products across subsidiaries located in different countries, something that domestic firms, by definition, cannot do.

each country on the world capital market. The fixed factor (land) is location-specific and supplied inelastically. The income from the fixed factor reflects an economic rent.

Households are modeled in an overlapping generation framework with a young and an old generation. Households maximize their intertemporal utility function subject to a budget constraint, where net savings from young workers (wages, current transfers, and negative consumption) are equal to the negative value of net savings from old households. Households' savings are allocated to bonds and stocks, which are imperfect substitutes and have different rates of return. The gross returns to assets are determined on world markets and are assumed to be the same irrespective of the residence of their owner. Total bond and stock holdings are derived from the maximization of total assets (combining bonds and equities) subject to their total value. The effects on welfare are calculated using the compensating variation, computed as the additional transfer required by young households to compensate for the change in utility.

Governments keep their budgets balanced, with consumption and public debt as fixed shares of GDP. Tax revenues and/or transfer payments adjust to keep a constant public budget. Taxes include indirect taxes on consumption and direct taxes on income from capital and labor, dividends, capital gains, and interest payments. The expenditure side features government consumption, interest payments on public debt, and lump-sum transfers. The data and policies of each country are used to replicate the corporate taxation regime, the production structure, and household behavior. This paper uses the calibration of the model performed by Alvarez-Martinez et al. (2016a) for the latest European Commission CCCTB proposal (European Commission, 2016).

3.2. Modeling tax compliance costs in CORTAX

Among the alternative corporate tax specifications, the CORTAX model accommodates compliance costs incurred by firms to comply with their corporate tax obligations. Tax compliance costs are modeled as variable costs and measured as the share of the total labor force employed to deal with tax administration. Overhead labor dedicated to tax compliance tasks is designed as a fixed fraction of the productive workers and increases the wage cost by this fraction. It follows that compliance costs proportionally increase in the payroll of the firm.⁶ In the following, we describe in detail how tax compliance costs potentially influence investment behavior by firms. The system of equations follows from Alvarez-Martinez et al. (2016a, 2016b). However, moving beyond this setting, we design compliance costs with a country-specific dimension to make use of our dataset. The production function Y is a Cobb Douglas combination of the fixed factor (A^{nx}) and value added ($VA(j)^{nx}$):

$$Y^{nx}(j) = A^{nx} (VA(j)^{nx})^{\alpha_v^n} \quad (1)$$

where $A^{nx} = (A_{0x} \omega^n N^y)^{1-\alpha_v^n}$. The fixed factor A_{0x} is weighted by the size of the young generation (N^y). The term ω^n is the exogenous fraction of the fixed factor. In the case of subsidiaries (f), there is an intermediate input ($Q(j)^{z_q}$) supplied by their headquarters:

$$Y^{fx}(j) = A^{fx} Q(j)^{z_q} (VA(j)^{fx})^{\alpha_v^f} \quad \text{with } 0 < \alpha_q + \alpha_v^f < 1 \quad (2)$$

value added is a CES function of labor ($L(j)$) and capital ($K(j)$):

$$VA(j)^{nx} = A_{0x} \left[\alpha_{vl}^n (L(j)^n)^{\frac{\alpha_v^n - 1}{\alpha_v^n}} + \alpha_{vk}^n (K(j)^n)^{\frac{\alpha_v^n - 1}{\alpha_v^n}} \right]^{\frac{\alpha_v^n}{\alpha_v^n - 1}} \quad (3)$$

We derive the demand for the factors of production from the FOC of the firms' maximization problem. In this paper we are concerned with the demand for labor, which includes a share of overhead labor dedicated to tax compliance activities (α_i in equations Eqs. (4) and (5) for multinational headquarters (m) and subsidiaries (f) in country j , respectively) that will accommodate our alternative estimates for compliance costs. Under competitive markets, the demand for labor equals the marginal productivity of labor with the marginal cost.

$$(1 + \alpha_i)w = \alpha_v^m \left(\frac{Y^m}{VA^m} \right) \alpha_{vl}^m A^{1-\frac{1}{\alpha_v^m}} \left(\frac{VA^m}{L^m} \right)^{\frac{1}{\alpha_v^m}} \quad (4)$$

$$(1 + \alpha_{ij})w(j) = \alpha_v^f \left(\frac{Y^f(j)}{VA^f(j)} \right) \alpha_{vl}^f A^{1-\frac{1}{\alpha_v^f}} \left(\frac{VA^f(j)}{L^f(j)} \right)^{\frac{1}{\alpha_v^f}} \quad (5)$$

⁶ The empirical literature on private compliance costs clearly points to such costs increasing in firm size, but marginally decreasing, which implies that the ratio of compliance costs over total workforce costs is decreasing in firm size. In the CORTAX model, we model representative firms; therefore we do not account for differences in firms' size while we capture the heterogeneity in compliance costs across countries. While ruling out the concavity of the compliance costs w.r.t. firm size is indeed a simplification, it does not meaningfully affect the results from our simulations, for at least two reasons. First, the combined effect of changes in firm size are second-order behavioral responses relative to the first-order mechanical effects of changes in tax bases and tax rates. Second, the degree of concavity of the relation between the share of compliance costs and total costs is (according to the available empirical evidence) rather small.

with α_l being the fraction of productive workers devoted to tax compliance tasks, α_v the share parameter of value added, α_{vl} the share parameter of labor in value added, σ_v^d the substitution elasticity labor/capital, A the productivity level, w the wage rate, Y production, VA value added, and L employed labor.

Modeling tax compliance costs as overhead labor dedicated to tax compliance tasks implies that changes in tax compliance costs resulting from the implementation of the CCTB and the CCCTB will directly affect the cost and the demand for labor and therefore production. The CCTB and CCCTB might therefore be assimilated to an efficiency gain in production, as a lower share of labor would be needed to perform activities that bring no additional economic gains. A reduction of tax compliance costs indirectly increases the average productivity of the workforce while reducing wage costs and the cost of production. Importantly, the reduction in tax compliance costs resulting from the reform is proportional to the multinational sector in the country, given that the cost of tax compliance for operating across EU borders is, by definition, incurred only by multinationals. As the multinational sector is proxied on FDI, the reduction or removal of compliance costs for subsidiaries will affect countries with large FDI more.

4. Calibration of country-specific tax compliance costs

To calibrate tax compliance costs used in the CORTAX model, we must rely on external estimates. Existing studies measuring business tax compliance costs rely mainly on structured surveys with relatively small samples (Eichfelder & Vaillancourt, 2014). These studies suggest that estimates for tax compliance costs tend to decrease with firm size. Internal time effort and personnel expenses are the most relevant part of the burden. The number of cross-country comparative studies is limited, however. Evans et al. (2014) report on exploratory research conducted in four countries (Australia, Canada, South Africa, and the United Kingdom) in 2010 and 2011. The European Commission (2004) surveyed 700 companies across 14 member states in 2003 via the European Tax Survey, but the low response rate undermined the representativeness of these results. OECD (2001) catalogued 8000 small and medium-sized enterprises in 11 OECD countries (Australia, Austria, Belgium, Iceland, Mexico, New Zealand, Norway, Portugal, Spain, and Sweden). In their study, Klun and Blazic (2005) cover Slovenia and Croatia. The variety of approaches used and the absence of estimates covering a large number of EU countries make it difficult to set a commonly accepted value for tax compliance costs. In a review of existing studies, Devereux (2004) reported a range of between 2.7% and 4% of corporate income tax revenues collected. The impact assessments conducted by the European Commission in 2011 and 2016 retained the upper end value of these estimates (4%) for all EU countries as central estimate, which seemed reasonable in the absence of representative survey data. However, the use of a common estimate for tax compliance is likely to limit cross-country differences in the impact of the CCCTB. In addition, as we explain in more detail in the following, more recently available estimates suggest that 4% is likely to represent a lower rather than an upper bound of the cost of tax compliance related to cross-border business in the EU.

In this paper, we use a novel and unique study on tax compliance costs by KPMG, which was prepared for the Executive Agency for Small and Medium-sized Enterprises (hereafter the EASME/KPMG study).⁷ This survey was released in November 2018 and covers 20 EU countries. It sampled enterprises in mid-2016, following a stratification design based on of four enterprise sizes (micro, small, medium, and large plus super-large) and NACE one-digit industrial sectors (five sectors were considered). The final dataset comprises slightly more than 3000 respondents. For each respondent, data about the time spent internally on tax compliance and the monetary cost for outsourced compliance services are provided, together with information on turnover, number of employees, gross profit, and taxes paid (among other data).⁸ Thus, the data are richer than, for example, the World Bank's Doing Business database, which reports only internal time (and not outsourcing costs).⁹

Although the EASME/KPMG survey focuses on small enterprises, it is designed to provide statistically representative information on medium and large companies as well.¹⁰ However, the survey introduces an upward bias in the estimates because Small and Medium-sized Enterprises (SMEs) are known to face disproportionately larger tax compliance costs; see European Commission (2004). We therefore employ our estimates primarily to proxy for the relative differences in compliance costs across EU member states, rather than to infer information about the absolute levels. We also aim to exclude companies whose information might not reflect normal (i.e., business-as-usual) tax compliance costs, in order to calculate country average private tax compliance costs. For this we exclude very small companies, as we aim to represent the average compliance costs for a typical firm. We also want to exclude companies experiencing temporary distress, as the information on tax compliance costs might be significantly influenced by temporary circumstances that do not reflect business-as-usual conditions. In addition, as the survey covers only a cross-section of firms, no information is available about the level of turnover from past periods; thus we cannot tell if an observed low turnover is due to the size of the firm or to abnormally low economic performance. Therefore, we excluded all respondents with less than 500,000 EUR turnover. We also eliminated the top 5% turnovers to reduce the weight

⁷ The EASME/KPMG study was published on 12/12/2018 and is available at: <https://publications.europa.eu/s/kVno>.

⁸ The final report by EASME/KPMG does not provide any information about the split between domestic and foreign compliance costs, though the way questions are posed in the survey strongly suggests that they relate to domestic costs only.

⁹ See <http://www.doingbusiness.org/en/reports/thematic-reports/paying-taxes>.

¹⁰ The draft second interim report of the EASME/KPMG survey states that "The agreed sampling method used is a disproportionate stratified sample, requiring a minimum number of completes per cell and including size and sector strata. This allows sufficient sample sizes to draw conclusions across all sectors and enterprise sizes. A representative sample might have entailed the risk of not being able to make statistically relevant conclusions for larger enterprises. To ensure representativeness for further qualitative analysis, the samples are weighted towards the actual proportion of enterprises."

of a few very large companies in the computations of country means. This was necessary as very few observations comprise very large companies, and their size is uneven across countries. This is because the survey's stratification applies only one selection criterion for the largest firms (the ones falling into the large and super-large bin). These are those enterprises with >250 employees or >€50 million turnover or >€43 million balance sheet total. Therefore, just one extremely large company sampled in one country might produce an extremely low cost-to-turnover ratio and artificially pull down the mean for that country.

The EASME/KPMG survey also asks about the type of enterprise; thus we could distinguish between stand-alone companies and companies that are part of a group. This is important because belonging to a group might increase the reported figures for the compliance costs (as companies need to perform more tasks, for example, to deal with cross-border trade), but it might also reduce them (as economies of scale and centralized compliance management may reduce reported costs by the individual affiliate). We consider only enterprises that are subject to corporate taxation.¹¹ For each country, separately for stand-alone firms and group affiliates, we compute the mean number of hours spent in tax compliance internally divided by turnover, and multiply it by the average hourly cost of labor in that country in 2016 (obtained from Eurostat) to get a measure of Euro-equivalent tax compliance costs. For each country, we then compute the mean of outsourcing costs as a share of turnover (again, separately for stand-alone firms and group affiliates) and add them up to obtain the total internal costing estimate. In the end, we obtain two series of tax compliance cost figures expressed as shares of turnover, one for stand-alone enterprises and one for group affiliates, for 17 EU countries. Finally, to convert the two series into shares of labor costs, which is the way compliance costs are represented in the CORTAX model, for each EU member we compute labor costs as a percentage of turnover using the Orbis Bureau van Dijk© data for 2014,¹² and then we divide our figures by that number. The simple average of the two series (for stand-alone firms and group affiliates) is used as an estimate of the tax compliance costs (expressed as a share of labor costs) for each EU member state. When estimates are not available for a country, we assign the EU GDP-weighted mean to EU countries.¹³ Note that these estimates cover only private tax compliance costs, that is, costs that burden companies. We do not account for the public compliance costs that burden tax agencies or the reform's impact on them.

As discussed above, the previous impact assessments of the CCCTB conducted in 2011 and 2016 assumed that tax compliance costs represented 4% of total corporate income tax revenues collected, which corresponded to a ratio of 0.5% when compliance costs were measured as a proportion of labor costs (see Alvarez-Martinez et al., 2016a; Bettendorf & van der Horst, 2006). In addition, the previous impact assessments assumed that such costs were identical across countries. Using data from the newly released EASME/KPMG survey, we find that such costs are nearly three times larger than the previous estimates, representing (on average across countries) 1.38% of total labor cost and 12% of total corporate income tax revenues collected (weighted averages using GDP as weights). With these caveats in mind, we designed two alternative baselines for calibrating tax compliance costs in CORTAX. The first baseline is obtained by equating the GDP-weighted EU mean of country-specific estimates to the 1.38% ratio of compliance costs to labor cost or, equivalently, to 12% of corporate tax revenues.¹⁴ Note, though, that a cost-to-CIT revenues ratio of 12% is a much larger figure than those commonly found in the literature. For instance, European Commission (2004) found a comparable value of 2.6% for SMEs across several countries; the OECD (2001) found values between 2% and 7% (as well using a multi-country sample); Eichfelder and Vaillancourt (2014) reported values in the range of 0.4% to 4% for SMEs in individual countries. Only in a few studies did any estimates exceed 10% (for Belgium, Croatia, and New Zealand). Our chosen value of 12% of corporate tax revenues (or equivalently 1.38% of labor cost) must therefore be considered an upper-bound estimate. In the following, we label this the High baseline. For the second baseline, we follow the EC's impact assessments¹⁵ and keep the GDP-weighted EU mean of compliance costs (as a share of labour costs) equal to 0.5%, or equivalently, as a share of corporate tax revenues, to 4%. While maintaining comparable levels for EU averages, we accommodate estimates that differ across countries. In the following, we label the latter the Low baseline.

Table 1 shows our country estimates of tax compliance costs used in CORTAX, which correspond to the α_i in equations Eqs. (4) and (5). In the High baseline, the majority of countries end up with higher estimates than the common value; the exceptions are Estonia, Finland, Luxembourg, Slovenia, and Spain. In the Low baseline, Austria, Belgium, Germany, Italy,

¹¹ When the number of stand-alone companies for a country was below 10, we used instead enterprises that are subject to business taxation rather than corporate taxes. This was the case for four countries: Ireland, Luxembourg, the Netherlands, and Slovenia.

¹² For more information on the Orbis data, see <https://www.bvdinfo.com/en-gb/our-products/data/international/orbis>. The Orbis dataset is known to suffer from some degree of selection bias and from errors in the reported values. We followed the methodology outlined in Chapter 5 of Kalemli-Ozcan et al. (2015) to clean the data and obtain country-level figures for the ratio of labor costs to turnover. We proceeded as follows: we kept values in Euros at current values; dropped any observations for which either information for total assets, turnover, or employment is missing; and dropped any observations for which employment or fixed assets were negative. We then compared aggregate figures (for employment and turnover) with comparable aggregates from National Accounting Data published by Eurostat, again following Kalemli-Ozcan et al. (2015), to spot potential biases. We concluded that the median values we computed from the Orbis data in the chosen period of time (2010–2013) provide a fair representation for each country in terms of sectors, though we acknowledge some degree of bias against small firms, which appear to be underrepresented for most of the countries in the Orbis dataset.

¹³ These countries are Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Portugal, Romania, and the UK. A different approach would be to assign to these countries the value from another country that is "similar enough." The latter approach encountered a number of practical obstacles, for instance, how to objectively define the degree of similarity between the tax systems (including most features that likely impact compliance costs, e.g., the quality of the judiciary system and the rule of law, the degree of bureaucratization, and the complexity and transparency of the tax code). We chose our solution, rough though it may be, because it does not imply subjective assessments. For the listed countries only, our results are not robust and should be taken with due care.

¹⁴ Instead of calculating country average values, we could have considered medians, especially in light of the stratification issues mentioned above. However, using median values would greatly underrepresent large firms, which are those managing a large share of GDP in the countries considered here.

¹⁵ See Alvarez-Martinez et al. (2016b).

Table 1
Tax compliance costs to total labor cost ratios (baselines).

Country	High baseline for tax compliance costs	Low baseline for tax compliance costs
Austria	2.02%	0.77%
Belgium	1.73%	0.66%
Bulgaria	1.38%	0.50%
Croatia	1.38%	0.50%
Cyprus	1.38%	0.50%
Czech Republic	1.38%	0.50%
Denmark	1.38%	0.50%
Estonia	0.12%	0.05%
Finland	0.40%	0.15%
France	1.14%	0.43%
Germany	2.36%	0.90%
Greece	1.38%	0.50%
Hungary	1.38%	0.50%
Ireland	1.38%	0.50%
Italy	1.62%	0.62%
Latvia	1.38%	0.50%
Lithuania	1.38%	0.50%
Luxembourg	0.47%	0.18%
Malta	1.38%	0.50%
Netherlands	0.89%	0.34%
Poland	5.61%	2.14%
Portugal	1.38%	0.50%
Romania	1.38%	0.50%
Slovakia	2.03%	0.77%
Slovenia	0.30%	0.11%
Spain	0.31%	0.12%
Sweden	3.69%	1.41%
EU average	1.38%	0.50%

Notes: These values feed into α_i in Eqs. (4) and (5). The High baseline uses the new EASME/KPMG survey data to calculate country-specific average values of the tax compliance costs measured as share of total labor costs. The Low baseline is pinned to the GDP-weighted EU mean as in the 2016 Impact Assessment of the CCTB by the European Commission (see Alvarez-Martinez et al., 2016b), while preserving cross-country differences as reflected in the newly released EASME/KPMG data. The EU average figures are GDP-weighted means.

Poland, Slovakia, and Sweden are assigned higher-than-average values, whereas Estonia, Finland, France, Luxembourg, the Netherlands, Slovenia, and Spain are assigned lower-than-average values. As explained above, we assign the EU GDP-weighted mean to the remaining countries.

5. New simulations for the CCTB and CCCTB under alternative tax compliance costs

In the first stage of the proposed reform (CCTB), multinationals will define their tax base according to a single common definition. As Alvarez-Martinez et al. (2016b) explain, the harmonized tax base is defined as follows: a 12.5% straight line depreciation rate for machinery (8 years), a 4% rate for industrial buildings (25 years), a 6.67% rate for intangibles (15 years), and an average-value pricing for inventories. The net present values of depreciation allowances are computed following Devereux and Griffith (2003). We calculate two values: the first-year allowance and the net present value of other depreciation allowances for each asset class. We then use the Orbis data from Bureau van Dijk© to calculate the median values by country, based on firm-specific data on asset structures.¹⁶ Tax base harmonization does not result in identical tax bases for all countries, as each country has a different assets structure. Across member states, this would translate into a narrowing or broadening of the tax base depending on the national rules in place before harmonized tax bases. In the second stage (CCCTB), firms will be allowed to consolidate their tax bases across subsidiaries according to a formula apportionment; they will also be able to carry losses forward and offset profits against losses across member states. In the model simulation, the reforms are tax revenue neutral. We allow CIT rates to adjust ex ante in order to keep CIT revenues unchanged before firms' behavioral responses. The government budget is balanced by adjusting transfers to the old generation.

Alvarez-Martinez et al. (2016b) provide the first assessment of the CCCTB proposals, highlighting the main general equilibrium mechanisms driving the results. On average, the harmonization of corporate tax bases causes a narrowing of the common tax base in the EU. The resulting reduction in the cost of capital boosts investment and exerts a positive impact on the productivity of labor, stimulating wages and employment. As a result, GDP and welfare increase. Under the consolidated corporate tax base, the shift to the formula apportionment has allocative implications and removes the incentive to shift profits within the EU. However, much of the benefit comes from the significant reduction in tax compliance costs that, via the general equilibrium framework, leads to higher welfare and GDP by reducing the cost of production. These results were based on the assumption that tax compliance costs were identical across countries. In this paper, unlike

¹⁶ Again, see the previous footnote 12 about possible selection bias in the Orbis data in favor of larger companies.

Alvarez-Martinez et al. (2016b), we focus on interpreting the new insights we get from having better (i.e., country-specific) modeling of compliance costs. In Sections 5.1 and 5.2, we discuss the impact of our alternative estimates of tax compliance costs on CCTB and CCCTB for the High and Low baselines for tax compliance costs. Appendix Tables A1 to A4 present the country-specific results, which we briefly summarize below.

5.1. Results for the CCTB

We follow previous impact assessment exercises conducted by the European Commission services and assume that tax compliance costs faced by multinational subsidiaries decline by 30% thanks to the CCTB (European Commission, 2011b).¹⁷ Results for the CCTB under alternative estimates for tax compliance costs are driven mainly by labor demand, the substitutability between labor and capital, and their impact on production. As modeled in equations (4) and (5), reduced tax compliance costs directly lower the increase in wages caused by the new definition of the tax base, via the α_l coefficient. This translates into a relatively higher demand for labor, as this factor of production become less costly. In a competitive market, changes in labor demand affect the productivity of capital and therefore the substitutability between the two factors of production. More labor-intensive countries will be the most affected. Overall, the boost in demand for the factors of production results in a higher level of production in the economy. On the supply side, workers respond by supplying more labor. Welfare in the economy improves.

Under the assumption of ex ante revenue neutrality, firms' corporate tax rates (adjusted for profit shifting) are modified to compensate for changes in the tax base resulting from the implementation of the common definition. In particular, some countries that experience a narrowing of the tax base (such as Germany, Poland, and the UK) raise their CIT rate to compensate for the decline in collected revenues. In contrast, countries like Belgium and Estonia reduce their CIT rates in response to the broadening of their tax bases. At the EU level, we record a narrowing of the tax base that reduces the marginal effective tax rate. We also see a slightly higher average corporate tax rate that increases the burden on capital, which distorts firm decisions, but the CIT rate is also levied on pure rents, which is non-distortionary.¹⁸ Overall, the distortive impact of the corporate tax rate on the cost of capital is slightly mitigated. Changes in CIT rates across countries also modify incentives to engage in profit shifting (see the equations in the Appendix B). In the EU, profit shifting across member states tends to fall under the CCTB. The extent to which profit shifting affects the tax base depends on the size of the bilateral FDI stocks, as they represent a proxy of intra-firm trades. Therefore, the tax revenues of countries with important FDI stocks are more affected by profit shifting than the tax revenues of countries with small FDI stocks.

Comparing results for the CCTB across scenarios, we find a larger positive impact on the main macro variables under the High baseline than under the Low baseline (Table 2). Tax compliance activities can be considered distortive and therefore harmful to economic efficiency. The efficiency gain resulting from the harmonized tax base has a positive impact on all variables. However, employment increases slightly less under the High baseline. The CCTB brings about a greater absolute reduction in compliance costs under the High baseline than under the Low baseline, but post-CCTB compliance costs are still higher in absolute terms under the High baseline than under the Low baseline. The higher compliance costs both before and after the CCTB dampen the increase in employment stimulated by the increase in production. However, higher wages positively affect welfare.

With new estimates of tax compliance costs that differ across countries, the benefits of the reduced costs also differ. Since some countries benefit more than others, they gain a competitive advantage in attracting foreign investment. Countries that benefit less from the CCTB might thus be worse off. Indeed, our results suggest that countries with lower baseline compliance costs are better off than those with higher baseline costs. All member states are better off after the CCTB under the High baseline than they are under the Low baseline, but the benefit decreases with raising levels of compliance costs. Luxembourg, the Netherlands, and Spain, for example, gain particularly under the High baseline; on the contrary, Germany, Italy, and Sweden show comparable performances. Results across baselines indicate that countries with a large presence of multinational subsidiaries (large FDI) see the effect amplified. Examples are Belgium, Finland, Luxembourg, and Sweden. Outside of the EU, the spillover effects on Japan and the US are negligible.

5.2. Results for the CCCTB

Consolidation is expected to bring major benefits in terms of reduced tax compliance costs, even though the size of the reduction is difficult to predict. When simulating the impact of the CCCTB, we set compliance costs paid by subsidiaries to zero. (In doing so, we follow previous impact assessment exercises conducted by the European Commission services. We amend this assumption in Section 5.4 below.) Several effects need to be disentangled when analyzing the CCCTB in combination with alternative assumptions on compliance costs. The consolidated tax base will also remove any incentive to shift profits across the EU, which prevents the distortive allocation of the tax base; it also allows for loss consolidation, which reduces the tax burden. Since compliance costs are modeled as variable costs, their removal reduces the cost of production and exerts a positive impact on GDP and welfare. Accommodating country-specific estimates for compliance costs intro-

¹⁷ We consider alternative cost reductions in Section 5.4.

¹⁸ The version of the CORTAX model we employ here assumes that multinational firms set their FDI at the margin but perform FDI in all countries modeled. An alternative specification, which we do not explore in this paper, could assume a discrete choice framework where multinationals may also decide where to perform FDI. In the latter case, taxing pure rents might be distortionary.

Table 2
Economic effects of the CCTB reform in the EU.

	CCTB	
	High baseline for tax compliance costs	Low baseline for tax compliance costs
Cost of capital (% points change)	-0.078	-0.077
Investment (percentage change)	1.140	1.074
Wage (percentage change)	0.332	0.283
Employment (percentage change)	0.103	0.107
GDP (percentage change)	0.383	0.332
Welfare (% GDP)	0.117	0.079

Notes: See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

Table 3
The CCCTB reform's economic effects on the EU.

	CCCTB	
	High baseline for tax compliance costs	Low baseline for tax compliance costs
Cost of capital (% points change)	-0.087	-0.083
Investment (percentage change)	1.270	0.925
Wage (percentage change)	0.670	0.436
Employment (percentage change)	0.246	0.258
GDP (percentage change)	0.505	0.269
Welfare (% GDP)	0.196	0.023

Notes: See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

duces heterogeneity across countries, mostly in terms of benefits from the consolidated tax base. Aggregate responses to the reform are significantly larger under the High baseline than under the Low baseline (Table 3), highlighting the role of compliance costs in generating benefits under the CCCTB.

Country results (Tables A2 and, A4) are driven by the relative level of tax compliance costs in the baseline and the presence of foreign subsidiaries in the country. The relative sizes of multinationals and domestic firms (in terms of national production) also play a role. The economic impacts are amplified or weakened depending on the size of FDI stock and therefore the presence of multinational subsidiaries in the country. Countries with many subsidiaries will be more responsive to the CCCTB than countries with only a few. Countries with relatively small shares of multinationals include Germany, Italy, and Poland, where the reduction in the relatively large estimates of tax compliance costs is not fully transmitted to employment and GDP. By contrast, in Belgium, Denmark, Finland, Luxembourg, and Malta, the large size of subsidiaries hosted by the country ends up reinforcing the effect of reduced tax compliance costs. Results show that countries with more foreign subsidiaries and countries with lower baseline compliance costs benefit more from the CCCTB, with significant gains in GDP, employment, and welfare. The reduced tax compliance costs resulting from the reform also benefit non-EU countries operating in the European market, although these impacts are negligible.

5.3. Comparing multinationals and domestic firms

An important dimension of the analysis is to differentiate between domestic and multinational firms. Because the reform will be mandatory only for multinationals, firms will therefore be affected differently depending on their type. In this section, we analyze the extent to which the CCTB and CCCTB might favor multinationals over domestic firms. Alternatively, our analysis can be used to determine domestic firms' incentives to engage in foreign direct investment due to the reduced tax compliance costs brought about by the CCTB and CCCTB.

Domestic firms (or, alternatively, domestic investment) will not benefit from the reduction in tax compliance costs, since, by definition, they do not operate across borders. The asymmetric framework of the reform will thus give multinationals a competitive advantage by lowering their production costs.¹⁹ The results that show production changes by firm type indicate a significant shift in favor of multinationals under the CCCTB proposal (Table 4). The key benefit to multinationals from the consolidated tax base is the lowering of tax compliance costs, which more than offsets the additional costs resulting from the removal of profit shifting within the EU. Under the CCTB, the impact is rather small. Results are amplified under the scenario using the High baseline for tax compliance costs.

5.4. Varying the size of the reduction in compliance costs

We also checked whether the differential impact of the CCCTB between domestic firms and multinationals depends on the assumption regarding the decrease in compliance costs. To determine the extent to which our results depend on this

¹⁹ The legal proposal mentions the possibility that domestic firms may be able to opt in. However, we do not model this option in our analysis. Therefore, the results must be interpreted with this caveat in mind.

assumption, we designed scenarios for the CCCTB reform under different compliance costs reductions set at 100%, 60%, and 10% of the baseline values. We then compared them with the results under the 100% reduction corresponding to the value used in previous impact assessments conducted by the European Commission services. As Figures 1 and, 2 show, the larger the reduction in tax compliance costs and the pre-reform share of compliance costs to labor costs, the larger the shift in production from domestic firms to multinationals.

Table 4
Effect on production by category of firm.

	CCTB High baseline for tax compliance costs	CCTB Low baseline for tax compliance costs	CCCTB High baseline for tax compliance costs	CCCTB Low baseline for tax compliance costs
Domestic	-1.37	-0.29	-20.75	-16.82
Multinational	2.71	1.21	26.41	20.68

Notes: See the footnote to Table 1 for definitions of the baseline scenarios for tax compliance costs.

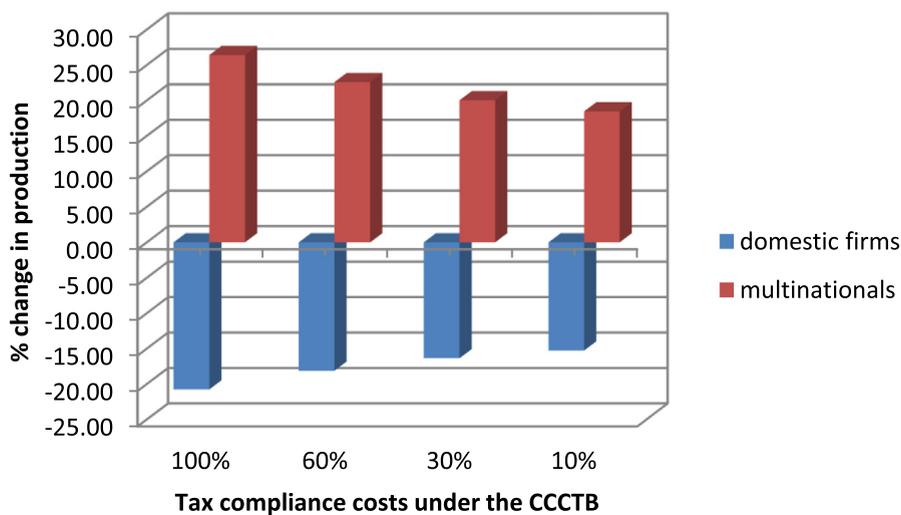


Fig. 1. Effect on production by category of firm – CCCTB. High baseline for tax compliance costs. Notes: See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

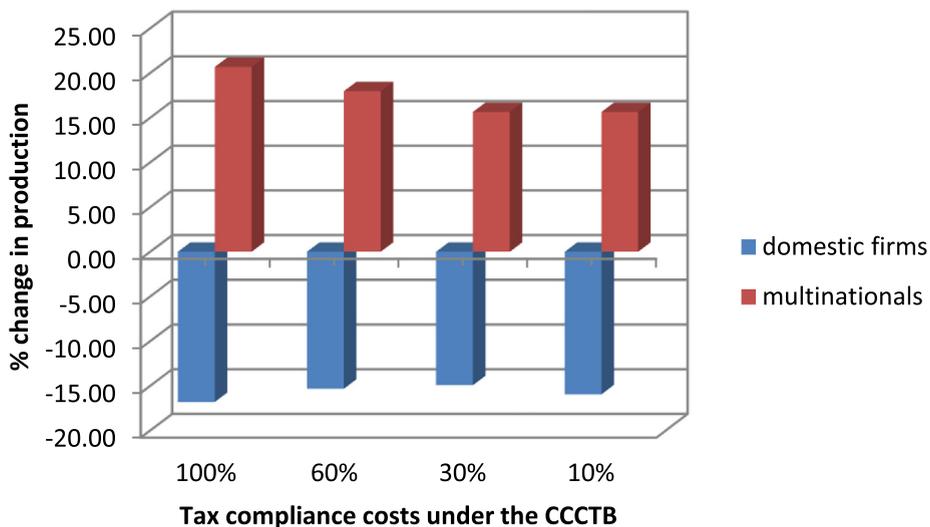


Fig. 2. Effect on production by category of firm – CCCTB. Low baseline for tax compliance costs. Notes: See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

As noted previously, these results do not mean that domestic firms would necessarily be penalized under the CCCTB. In fact, the results of the survey conducted by the European Commission in 2003 suggested that tax compliance costs were significantly higher for cross-border operations of SMEs than for large multinationals; see [European Commission \(2004\)](#). Domestic firms, usually SMEs, would therefore also benefit from the reduction in tax compliance costs via the CCCTB for potential cross-border operations. This is confirmed by our results. However, since our model does not allow firms to change their status (e.g., a domestic firm cannot become a multinational), we can only infer this interpretation from comparative statics. Our analysis suggests, therefore, that the cost of cross-border investment would fall relative to the cost of domestic investment, thereby potentially benefiting domestic firms (or SMEs) willing to engage into foreign direct investment.

6. Conclusion

This paper sheds light on the macroeconomic effects of expected reductions in tax compliance costs brought about by the harmonization of corporate tax bases in the EU (under the CCTB proposal) and the consolidated reporting of corporate tax revenues and the possibility for multinationals to offset losses across EU member states (under the CCCTB proposal). Past impact assessments of these proposed reforms were based on the assumption that both pre-reform tax compliance costs (measured as share of labor costs) and post-reform variations were identical across countries. This assumption was due to the absence of reliable country-specific estimates of tax compliance costs. These costs are likely to differ across countries due to institutional differences, however. As a result, some countries are likely to gain relatively more, or less, from the harmonization of corporate tax bases.

In this paper, we exploit a unique dataset measuring tax compliance costs across several EU countries from a recent survey commissioned by the EU agency EASME. Our goal is to investigate the possible macroeconomic impact of the CCTB and CCCTB proposals using a general equilibrium framework. In contrast to previous impact assessments conducted by the European Commission, our framework allows us to calculate country-specific tax compliance costs and therefore to produce more differentiated analyses across countries. We use the new data to calibrate the CORTAX model used in previous impact assessments of the CCCTB proposal. The CORTAX model captures in a stylized way the many interactions (including cross-border activities) through which the reduction in tax compliance costs linked to the implementation of the CCTB and CCCTB could impact EU countries. We model tax compliance costs as a constant share of labor cost. The CCTB and CCCTB might therefore be assimilated into an efficiency gain in production, as a lower share of labor would be needed to perform activities (i.e., activities related to tax compliance) that per se add no economic value.

Our simulation results support the view that the expected reduction in compliance costs would be associated with greater economic efficiency, as fewer resources (in terms of labor) need to be allocated to tax compliance activities. The mechanism operates through the labor market and the direct impact that changes in the cost of labor exert on employment: a reduction of tax compliance costs indirectly increases the average productivity of the workforce while reducing wage costs and the cost of production. The reduction in tax compliance costs following the reform is also proportional to the multinational sector in the country, given that the CCCTB would apply only to multinationals, and these firms would no longer have to comply with different corporate tax regimes for their cross-country operations.

Holding all else constant, we find that countries with lower baseline compliance costs benefit more from the reforms, because they are the ones that will end up with the larger reduction in labor costs resulting from the reforms. Examples are Luxembourg, the Netherlands, and Spain. This finding implies that countries that currently have large compliance costs might want to invest in improving their tax systems to reap greater benefits from the C(C)CTB reform(s). Another way to frame these results is to consider declining compliance costs not only as the outcome of the proposals, but also as a complementary policy action to improve the benefits expected from the reforms.

Our results also suggest that countries with a large number of inward foreign investments are more responsive to the CCCTB (countries such as Belgium, Denmark, Luxembourg, and Malta). This is due to the link between compliance costs and the cost of capital, as reduced compliance costs induce multinationals to invest more in their foreign affiliates. Finally, we show that the CCCTB reform would cause a shift in production that would benefit multinationals to the detriment of domestic firms, although this would depend on the reduction in compliance costs effectively achieved through the CCCTB. The latter result also indicates that domestic firms willing to undertake cross-border investment would benefit from the reduction in tax compliance costs brought about by the CCCTB.

Future research should consider the mediating heterogeneous effects of changes in compliance costs across countries when estimating the impact of EU-wide policies, as we have shown that they can play a major role. Some specific research avenues seem desirable. First, the CGE model we employed derives steady-state equilibrium solutions, but policy-wise it is also relevant to gain insight about the transitions toward such long-term equilibria. For this purpose, one would need a model that solves recursively and thereby provides simulated transition paths toward the steady state. Second, in our simulations countries change corporate tax rates in a stylized way, targeting only ex ante revenues. A more sophisticated model might account for strategic behavior and its effects on profit-shifting incentives. Third, we did not differentiate between private and public compliance costs. A reform like the CCCTB might, however, cause different reductions to one or the other. For example, the reform could make exchanging tax data across national tax agencies either easier or more cumbersome, which could affect private and public compliance costs differently.

Disclosures

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They should not be attributed to the European Commission.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Country results

Table A1
CCTB – High baseline for tax compliance costs.

	CIT_rate	CoC	Capital	Wage	Employm.	GDP	Rev_CIT	Rev_tax	Welfare
Austria	1.97	-0.06	0.98	0.37	0.08	0.40	-0.15	0.01	0.16
Belgium	-11.09	0.05	-0.86	0.21	-0.47	0.41	0.12	0.06	0.48
Bulgaria	0.00	0.02	-0.38	-0.15	-0.07	-0.10	0.11	0.06	-0.02
Croatia	-9.19	0.17	-2.57	-0.78	-0.24	-0.37	0.35	0.03	-0.21
Cyprus	0.00	0.03	-0.56	-0.16	-0.13	-0.16	0.14	0.07	0.02
Czech Rep	-0.73	0.02	-0.13	-0.01	-0.02	0.06	0.03	0.02	0.01
Denmark	-1.32	0.03	-0.22	0.09	-0.08	0.16	0.06	0.06	0.14
Estonia	-9.49	0.13	-2.12	-0.80	-0.24	-0.59	0.22	-0.08	-0.18
Finland	-1.59	0.04	-0.15	0.08	-0.01	0.18	0.03	0.06	0.06
France	-2.67	0.08	-0.80	-0.10	-0.16	-0.13	0.13	0.03	0.08
Germany	2.43	-0.08	1.12	0.36	0.12	0.41	-0.15	0.00	0.11
Greece	-4.13	0.07	-1.18	-0.44	-0.18	-0.51	0.13	-0.05	-0.11
Hungary	0.31	0.00	0.13	0.06	0.03	0.18	-0.02	0.01	0.01
Ireland	-0.05	0.00	0.11	0.15	-0.07	0.31	0.03	0.06	0.15
Italy	-1.42	-0.07	1.16	0.51	0.15	0.50	-0.29	-0.06	0.18
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
Latvia	-4.69	0.07	-1.05	-0.41	-0.13	-0.34	0.10	-0.04	-0.12
Lithuania	-4.69	0.12	-2.15	-0.90	-0.31	-0.90	0.34	0.04	-0.21
Luxembourg	-0.31	0.00	0.35	0.32	-0.01	0.40	-0.26	-0.16	0.23
Malta	1.30	-0.05	1.11	0.60	0.10	0.72	-0.14	0.03	0.22
Netherlands	1.31	-0.06	0.95	0.37	0.07	0.32	-0.13	0.02	0.14
Poland	2.58	-0.08	1.29	0.46	0.17	0.58	-0.15	0.01	0.11
Portugal	-3.52	0.09	-1.19	-0.30	-0.16	-0.23	0.16	0.04	-0.02
Romania	-0.10	0.01	-0.08	-0.03	0.01	0.03	0.01	0.00	-0.03
Slovakia	-3.82	0.06	-0.96	-0.35	-0.12	-0.26	0.12	-0.01	-0.09
Slovenia	-0.67	0.01	-0.10	0.03	0.00	0.12	0.02	0.03	0.02
Spain	1.70	-0.09	1.64	0.52	0.25	0.65	-0.23	-0.01	0.10
Sweden	-1.12	0.03	-0.40	0.05	-0.23	0.04	0.08	0.02	0.28
UK	8.36	-0.49	6.21	1.23	0.61	1.29	-0.79	-0.20	0.15
US	0.00	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	0.00
EU	0.69	-0.08	1.14	0.33	0.10	0.38	-0.17	-0.02	0.12

Notes: CIT-rate = percentage point change in the corporate tax rate faced by multinational headquarters (accounting for profit shifting to tax haven and, in the case of C(C)CTB, consolidation of corporate accounts).

CoC = percentage point change in the cost of capital, average across all firms.

Capital = percentage change in total capital stock.

Wage = percentage change in the wage rate.

Employm. = percentage change in total employment.

GDP = percentage change in gross domestic product.

Rev_CIT = change in the corporate tax revenue in % of GDP.

Rev_tax = change in total tax revenue in % of GDP.

Welfare = change in compensating variation in % of GDP (positive value reflects a welfare gain).

Note: See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

Table A2
CCCTB – High baseline for tax compliance costs.

	CIT_rate	CoC	Capital	Wage	Employm.	GDP	Rev_CIT	Rev_tax	Welfare
Austria	-0.02	-0.13	0.92	0.66	0.13	0.44	-0.34	-0.07	0.29
Belgium	-3.32	0.56	-2.47	0.51	-0.78	-0.81	-0.18	-0.21	0.90
Bulgaria	0.29	0.03	0.22	0.56	0.20	0.03	0.00	0.17	0.14
Croatia	-8.70	0.18	-1.59	0.44	-0.04	-0.31	0.15	0.30	0.35
Cyprus	5.57	0.13	-0.75	0.25	0.06	-0.25	-0.02	0.06	0.09
Czech Rep	0.89	0.05	-0.01	0.42	0.23	0.16	-0.10	0.07	0.00
Denmark	1.69	0.12	0.17	0.81	0.08	0.65	-0.24	0.09	0.43
Estonia	-5.66	0.25	-0.71	0.26	-0.01	-0.22	-0.02	0.06	0.15
Finland	0.02	0.08	1.04	1.11	0.24	1.04	-0.17	0.34	0.42
France	-5.00	-0.01	0.44	0.47	-0.01	0.66	-0.21	-0.05	0.30
Germany	-0.10	-0.16	0.70	0.44	0.10	0.33	-0.35	-0.17	0.19
Greece	-1.11	0.15	-0.44	-0.07	-0.02	-0.20	0.01	-0.02	-0.02
Hungary	0.56	-0.01	0.40	0.50	0.32	0.36	-0.17	0.09	0.01
Ireland	11.50	0.28	-0.53	0.88	0.21	-0.55	-0.24	0.05	0.31
Italy	-1.43	0.14	-0.52	0.14	-0.10	-0.14	-0.08	-0.06	0.17
Japan	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	-0.01
Latvia	-1.34	0.12	-0.32	0.18	0.05	-0.04	0.04	0.10	0.06
Lithuania	-2.40	0.19	-0.43	0.06	0.03	-0.15	0.02	0.04	0.00
Luxembourg	-0.50	-0.07	0.03	0.34	0.54	1.15	-0.98	-0.80	-0.32
Malta	-2.85	-0.20	3.32	1.87	0.48	2.96	-0.56	-0.01	0.54
Netherlands	2.80	-0.05	2.03	1.66	-0.15	0.50	-0.27	0.29	1.03
Poland	2.56	-0.10	1.39	0.71	0.51	0.63	-0.37	-0.08	-0.04
Portugal	-0.54	0.16	-0.39	0.35	-0.02	0.04	-0.07	0.03	0.24
Romania	0.65	0.02	0.01	0.28	0.15	0.09	-0.03	0.08	0.04
Slovakia	-0.91	0.10	-0.22	0.30	0.02	-0.06	0.02	0.11	0.14
Slovenia	0.37	0.03	0.02	0.51	0.15	0.23	-0.02	0.19	0.17
Spain	-0.03	-0.19	2.33	0.77	0.70	1.15	-0.62	-0.20	-0.13
Sweden	0.14	0.05	-0.49	0.86	-0.79	-0.27	-0.20	-0.11	1.38
UK	4.93	-0.65	6.90	1.81	1.21	1.70	-1.40	-0.43	-0.15
US	0.00	0.00	0.01	0.00	0.01	0.02	0.02	0.02	-0.02
EU	0.03	-0.09	1.27	0.67	0.25	0.51	-0.41	-0.11	0.20

Notes: See notes at bottom of Table A1 for variable abbreviation definitions. See the footnote to Table 1 for definitions of the baseline scenarios for the tax compliance costs.

Table A3
CCTB – Low baseline for tax compliance costs.

	CIT_rate	CoC	Capital	Wage	Employm.	GDP	Rev_CIT	Rev_tax	Welfare
Austria	2.02	-0.06	0.91	0.30	0.10	0.34	-0.14	0.00	0.09
Belgium	-10.99	0.05	-0.88	0.11	-0.39	0.37	0.12	0.05	0.36
Bulgaria	0.00	0.02	-0.42	-0.18	-0.08	-0.16	0.11	0.05	-0.03
Croatia	-9.19	0.17	-2.60	-0.84	-0.25	-0.48	0.34	0.00	-0.23
Cyprus	0.00	0.03	-0.57	-0.20	-0.12	-0.21	0.14	0.06	-0.01
Czech Rep	-0.71	0.02	-0.20	-0.06	-0.03	-0.02	0.03	0.01	0.00
Denmark	-1.21	0.03	-0.38	-0.04	-0.07	0.02	0.07	0.03	0.05
Estonia	-9.46	0.13	-2.25	-0.87	-0.26	-0.70	0.23	-0.10	-0.19
Finland	-1.46	0.04	-0.39	-0.07	-0.04	-0.03	0.05	0.01	-0.01
France	-2.59	0.09	-0.91	-0.17	-0.16	-0.21	0.14	0.02	0.03
Germany	2.45	-0.08	1.11	0.33	0.14	0.41	-0.15	0.00	0.08
Greece	-4.13	0.07	-1.19	-0.45	-0.18	-0.52	0.13	-0.05	-0.11
Hungary	0.34	0.00	0.05	0.01	0.03	0.10	-0.01	-0.01	-0.02
Ireland	-0.02	0.00	0.04	0.07	-0.04	0.22	0.03	0.04	0.08
Italy	-1.39	-0.07	1.16	0.49	0.15	0.48	-0.28	-0.06	0.16
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
Latvia	-4.69	0.07	-1.09	-0.44	-0.13	-0.40	0.10	-0.05	-0.13
Lithuania	-4.69	0.12	-2.20	-0.93	-0.32	-0.96	0.34	0.03	-0.22
Luxembourg	-0.19	0.00	0.13	0.11	0.02	0.21	-0.25	-0.21	0.06
Malta	1.58	-0.04	0.72	0.29	0.10	0.40	-0.10	-0.01	0.06
Netherlands	1.44	-0.06	0.78	0.25	0.09	0.20	-0.12	0.00	0.06
Poland	2.60	-0.07	1.23	0.43	0.17	0.53	-0.15	0.00	0.09
Portugal	-3.48	0.09	-1.23	-0.34	-0.16	-0.27	0.17	0.03	-0.04
Romania	-0.09	0.01	-0.11	-0.06	0.01	-0.02	0.01	-0.01	-0.04
Slovakia	-3.79	0.06	-1.01	-0.39	-0.13	-0.32	0.12	-0.03	-0.10

Table A3 (continued)

	CIT_rate	CoC	Capital	Wage	Employm.	GDP	Rev_CIT	Rev_tax	Welfare
Slovenia	-0.62	0.02	-0.16	-0.02	-0.01	0.03	0.02	0.01	0.00
Spain	1.70	-0.09	1.53	0.49	0.22	0.60	-0.21	-0.01	0.10
Sweden	-1.02	0.03	-0.41	-0.04	-0.13	0.04	0.08	0.03	0.11
UK	8.42	-0.49	6.10	1.16	0.61	1.21	-0.77	-0.21	0.10
US	0.00	0.00	-0.01	0.00	-0.01	0.01	0.01	0.01	0.01
EU	0.73	-0.08	1.07	0.28	0.11	0.33	-0.16	-0.03	0.08

Notes: See notes at bottom of [Table A1](#) for variable abbreviation definitions. See the footnote to [Table 1](#) for definitions of the baseline scenarios for the tax compliance costs.

Table A4

CCCTB – Low baseline for tax compliance costs.

	CIT_rate	CoC	Capital	Wage	Employm.	GDP	Rev_CIT	Rev_tax	Welfare
Austria	0.33	-0.12	0.48	0.32	0.20	0.16	-0.26	-0.09	0.00
Belgium	-3.38	0.56	-2.33	0.19	-0.45	-0.81	-0.17	-0.23	0.45
Bulgaria	0.28	0.03	0.00	0.40	0.14	-0.15	0.00	0.12	0.09
Croatia	-8.65	0.18	-1.64	0.15	-0.06	-0.55	0.11	0.15	0.19
Cyprus	5.16	0.12	-0.78	0.08	0.07	-0.42	-0.01	0.02	-0.01
Czech Rep	0.92	0.06	-0.33	0.18	0.16	-0.14	-0.07	0.02	-0.06
Denmark	1.84	0.13	-0.53	0.21	0.09	0.03	-0.15	-0.04	0.04
Estonia	-5.52	0.25	-1.07	-0.04	-0.07	-0.50	-0.02	-0.04	0.05
Finland	0.29	0.09	0.03	0.41	0.13	0.22	-0.10	0.10	0.12
France	-4.60	0.01	0.02	0.20	-0.03	0.34	-0.15	-0.09	0.15
Germany	0.31	-0.15	0.58	0.31	0.18	0.26	-0.30	-0.15	0.03
Greece	-1.07	0.15	-0.47	-0.10	-0.02	-0.23	0.02	-0.02	-0.04
Hungary	0.73	0.00	-0.01	0.24	0.25	0.03	-0.12	0.02	-0.08
Ireland	11.08	0.27	-0.89	0.50	0.27	-0.85	-0.20	0.01	0.02
Italy	-1.35	0.15	-0.51	0.06	-0.06	-0.20	-0.08	-0.07	0.09
Japan	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	-0.01
Latvia	-1.33	0.12	-0.47	0.00	0.01	-0.24	0.03	0.03	0.00
Lithuania	-2.40	0.19	-0.61	-0.11	-0.01	-0.33	0.01	-0.02	-0.05
Luxembourg	-0.31	-0.07	-0.83	-0.39	0.51	0.32	-0.92	-0.98	-0.79
Malta	-2.01	-0.17	2.20	0.94	0.51	1.95	-0.50	-0.16	0.02
Netherlands	2.87	-0.05	1.30	1.13	-0.09	0.07	-0.22	0.16	0.69
Poland	2.16	-0.11	0.97	0.52	0.47	0.39	-0.32	-0.08	-0.12
Portugal	-0.59	0.16	-0.51	0.22	-0.01	-0.10	-0.07	-0.01	0.15
Romania	0.66	0.02	-0.12	0.17	0.11	-0.05	-0.02	0.05	0.01
Slovakia	-0.95	0.10	-0.39	0.12	0.01	-0.24	0.01	0.05	0.06
Slovenia	0.44	0.03	-0.18	0.27	0.10	-0.07	-0.02	0.10	0.07
Spain	0.08	-0.19	1.73	0.57	0.59	0.82	-0.55	-0.23	-0.15
Sweden	0.19	0.05	-0.36	0.47	-0.24	-0.11	-0.15	-0.04	0.55
UK	5.07	-0.64	6.02	1.38	1.17	1.19	-1.32	-0.50	-0.40
US	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	-0.01
EU	0.17	-0.08	0.93	0.44	0.26	0.27	-0.36	-0.14	0.02

Notes: See notes at bottom of [Table A1](#) for variable abbreviation definitions. See the footnote to [Table 1](#) for definitions of the baseline scenarios for the tax compliance costs.

Appendix B. The CORTAX model

CORTAX is a computable general equilibrium model originally developed by [Bettendorf and van der Horst \(2006\)](#). [Alvarez-Martinez et al. \(2016a\)](#) included some modeling extensions and recalibrated the model to the base year 2012.

CORTAX accounts for all main economic agents in the economy: firms, households, government, and the foreign sector. Each country accommodates one representative domestic firm, one multinational headquarters, and subsidiaries owned by headquarters located in the other countries.²⁰ The difference between domestic and multinational headquarters and the subsidiaries is the role of intermediate inputs and their capability to shift profits across countries. The parent company can shift profits to countries with low corporate income tax rates, charging a transfer price for intermediate deliveries that deviates from the equivalent price that would be charged if it had been an inter-firm transaction (the 'arm's-length' price). In order to ensure an interior solution, and following previous studies, a convex cost function is specified to describe the costs associated with the manipulation of transfer prices.

²⁰ The number of firms is not modeled in CORTAX. This simplification still allows us to interpret the results of the policy simulations by comparing the situations of multinational enterprises and domestic firms. Yet the relative importance of domestic versus foreign firms is represented by the contribution of FDI stock to the total capital stock.

$$c_q = \frac{|p_q - 1|^{1+\varepsilon_q}}{1 + \varepsilon_q} \quad (\text{A.1})$$

while the expression for transfer price is as follows:

$$\frac{\partial c_q}{\partial p_q} (1 - \tau_\pi^m) = \tau_\pi^f - \tau_\pi^m \quad (\text{A.2})$$

with τ_π^m the tax rate at the headquarters level and τ_π^{mf} the tax rate at the subsidiary level.

The model also captures the role of tax havens through the relation between domestic CIT rates and a low tax rate in the tax haven. The tax haven is represented by a hypothetical country where profit shifted therein can be expressed as follows:

$$\pi = A(\tau_p - \tau_{ph})^{1+\gamma} \quad (\text{A.3})$$

where π is the share of profit shifted to the tax haven, τ_{ph} is the low CIT rate in the tax haven, and γ is the elasticity of profit shifting to the tax haven. A is a parameter for the calibration.

In the model, labor and land are immobile factors in each country, and capital (and capital revenues) is perfectly mobile within the EU. The return to capital (after tax) is fixed by world capital markets. The supply of the fixed factor is location-specific and inelastic, and revenues generated are accounted for as economic rents.

Firms maximize their value $V_t^n(j)$, which is the discounted value of future dividends subject to the possibilities of the production function and accumulation constraints on physical capital (K^n) and fiscal depreciation (D^n):

$$V_t^n(j) = \sum_{s=t}^{\infty} \Lambda(j) D_i v_s^n(j) R_s(j) \quad (\text{A.4})$$

with $n = \text{domestic (d), multinational headquarters (m) or subsidiary (f)}$.

$$D_{t+1}^n = I_t^n + (1 - \delta_t) D_t^n \quad (\text{A.5})$$

$$K_{t+1}^n = I_t^n + (1 - \delta_k) K_t^n \quad (\text{A.6})$$

R_s represents the overall effect of discounting:

$$R_s(j) \equiv \frac{1}{(1 + \tilde{r}'_e(j))^{s-t+1}}; \quad \tilde{r}'_e(j) \equiv \frac{r_e(j,j)}{(1 - \tau_g(j))}; \quad \Lambda(j) \equiv \frac{(1 - \tau_d(j))}{(1 - \tau_g(j))} \quad (\text{A.7})$$

$\tilde{r}'_e(j)$ is the discount rate relevant for firms in making decisions, and $r_e(j,j)$ is net return on equity in country j for an investor also in country j (the marginal investor is assumed to reside in the home country). $\tau_g(j)$ is the tax rate on capital gains, and $\tau_d(j)$ is the tax rate on dividends.

Dividends are defined as follows:

$$D_i v_t^n = Y^n - wL^n - (d_b^n \hat{r}_{wb} + c_d^n) K^n - \Pi_t^n - \tau_t^n \hat{\Pi}_t^n - I_t^n + d_{b,t+1}^n K_{t+1}^n - d_{b,t}^n K_t^n \quad (\text{A.8})$$

Equation (B8) reads as follows: total production (Y^n) less labor cost (wage (w) times employment (L^n)), minus the deduction for the cost of debt, which is the deductible fraction of debt (β_b) multiplied by the share of debt financing (d_b^n), and the interest rate (\hat{r}_{wb}) plus the financial distress or agency costs (c_b^n), times the quantity of capital (K^n) less depreciation allowances ($\delta_t D^n$); Π_t^n is the return to fixed factors, $\hat{\Pi}_t^n$ the tax base, τ_t^n the corporate tax rate, and I_t^n investment.

The model accommodates old and young households that maximize their inter-temporal utility subject to their budget constraints. The optimal consumption path and labor supply are obtained from the first-order conditions. Household savings are allocated to bonds and stocks, which are imperfect substitutes and have different rates of return. The returns to assets are determined on world markets and are assumed to be the same irrespective of the residence of their owner.

Intra-temporal households' utility is calculated as a CES combination of the consumption and leisure of an old and a young generation. The intertemporal utility (U_t) is a Log-CES function of old (v^o) and young (v^y) intratemporal utility functions.

$$U_t = \frac{1}{1 - 1/\sigma_u} \left[(v_t^y)^{1 - \frac{1}{\sigma_u}} + \frac{\rho_0}{\rho_u^t} (v_t^o)^{1 - \frac{1}{\sigma_u}} \right] \sum_{\tau=0}^{T-1} \left(\frac{1 + g_a}{\rho_u} \right)^\tau \quad (\text{A.9})$$

where σ_u measures the degree of substitutability between consumption and leisure across years, ρ is a discount rate, and g_a is a growth rate. Households maximize this utility subject to their lifetime budget constraints:

$$\hat{w}_t^y l + tr_t^y - (1 + \tau_c) c_t^y = - \left(\frac{1 + g_a}{\rho_s} \right)^\tau [\pi_t^0 + tr_t^o - (1 + \tau_c) c_t^o] \quad (\text{A.10})$$

with \hat{w}_t^y being the after tax wage rate and tr_t^y being the current transfers received by young households. The terms c_t^y and c_t^o are consumption by the young and old generations, and τ_c is the corresponding consumption tax rate. The term π_t^o is the revenue generated by the fixed factor and received by old households, which are the owners of this factor.

The variation of welfare is calculated as the compensating variation, which is the variation in transfers received by young households required to reach the initial level of utility after a shock. The compensating variation is calculated as a percentage of GDP.

$$\text{compensating variation} = \frac{-tr_f^y(U_t^0) - tr_t^y(U_t^0)}{GDP_0} \quad (\text{A.11})$$

where $tr_f^y(U_t^0)$ are the transfers received after the shock that keep the initial utility level of households, and $tr_t^y(U_t^0)$ are the transfers before the shock. GDP_0 is the gross domestic product in the base case scenario.

Government is an intermediate agent. The budget is balanced, with consumption and public debt as fixed proportions of GDP. Lump-sum transfers to households (including transfer to the old and young generations) are also fixed. Tax revenues include indirect taxes on consumption and direct taxes on income from capital and labor, dividends, capital gains, and interest.

Finally, the foreign sector is an intermediate sector that accounts for the Balance of Payments adjustment. It captures the capital account, with the registration of net foreign assets, plus the trade balance, net foreign earnings on equities and bonds, and FDI.

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