CORPORATE TAX STATISTICS

Corporate Effective Tax Rates: Explanatory Annex

(Annex applicable for corporate effective tax rates 2019)

Corporate Effective Tax Rates: Explanatory Annex

Methodology, Exogenous Variables and Data Collection

1. This annex provides a summary of the variables and equations used to calculate the effective tax rates published in Corporate Tax Statistics. The methodology follows the model developed by Devereux and Griffith (1999, 2003) and applied by ZEW (2016, 2018) and others; the full model, as well as a derivation of the equations summarised in Annex B, is described by Hanappi (2018).

2. Table A.1 lists the exogenous variables used in the OECD model, grouping them in three categories: asset-specific, macroeconomic or tax-related. Given these variables, the equations in Annex B can be used to derive the respective results.

Table A.1. Exogenous Variables used in the OECD Corporate ETR Model

Variable	Description	Range	Category
p	Pre-tax rate of return	$0<p\leq 1$	(asset)
δ	Economic depreciation rate	$0<\delta\leq 1$	(asset)
r	Real interest rate	$r\lesseqgtr 0$	(macroeconomic)
i	Nominal interest rate	$0\leq i$	(macroeconomic)
π	Inflation rate	$0\leq \pi$	(macroeconomic)
τ	Corporate tax rate	$0<\tau$	(tax)
φ	Capital allowance rate (SL, DB)	$0<\varphi\leq 1$	(tax)
β	Capital allowance factor (DBSL)	$1\leq \beta$	(tax)
T	Project lifetime for tax purposes (DBSL)	$0<T$	(tax)
T^*	Optimal switching period (DBSL)	$0<T^*\leq T$	(tax)
A	Net Present Value of Capital Allowances	$0\leq A\leq \tau$	(tax)
v	Indicator for Inventory Valuation Method	$v=\{0; 0.5; 1\}$	(tax)
$\hat{\imath}$	Notional Interest Deduction (ACE)	$0\leq \hat{\imath}$	(tax)
$\hat{\tau}$	Tax rate applicable to notional interest	$0<\tau$	(tax)
N^{ACE}	ACE: Number of years over which the provision is spread (Belgium)	$N^{ACE}\geq 1$	(tax)
φ_{exp}	Share of initial investment expensed	$0<\varphi_{exp}<1$	(tax)
τ_d	Tax rate on distributions (Estonia, Latvia)	$0<\tau_d<1$	(tax)

3. Macroeconomic parameters include real and nominal interest rates as well as inflation. The database includes three different macroeconomic scenarios. In the first two scenarios, the macroeconomic parameters are fixed across countries which allows better comparisons of the tax systems, as differences across countries are not related to changes in the macroeconomic conditions.

4. In the third, country-specific macroeconomic parameters are set to be country-specific. Scenario nominal interest rates are sourced from the OECD Economic Outlook, the IMF International Financial Statistics, the European Central Bank or through direct contact with delegates or from public sources in a few instances. Using this data, 5-year averages of the long-term rate on government bonds (10 years) are constructed and a 5 percentage points risk premium is added to the corresponding real interest rate. This approach has several advantages. First, consistent data on government bond rates are available for a large subset of countries in the sample. Second, taking the 5-year average reduces year-on-year volatility in interest rates. Third, adding the risk premium to the long-term government bond rates better reflects the borrowing costs of corporates; in addition, it also ensures that real interest rates are not negative, which would imply a violation of one of the boundary conditions inherent in the theoretical model.

5. Table A.2 summarises the three macroeconomic scenarios and Table A.3 shows the country-specific values for the third scenario.

Table A.2. Macroeconomic Scenarios

Scenario		Inflation (%)	Real interest rate (%)	Nominal interest rate (%)
1	(fixed across countries)	2	5	7.1
2	(fixed across countries)	1	3	4.03
3	(country-specific)	(see Table A.3)	(see Table A.3)	(see Table A.3)

Table A.3. Country-specific Inflation and Interest Rates in Scenario 3

Country Code	Inflation (%)			Real interest rate (%)			Nominal interest rate (%)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
ALB	1.987	2.029	1.411	4.574	4.533	5.14	6.652	6.654	6.623
AND	2.4	0.7	1	4.173	5.129	4.995	6.673	5.865	6.045
AUS	1.972	1.934	1.551	6.016	5.855	5.809	8.107	7.902	7.45
AUT	2.231	2.12	1.505	3.837	3.684	4.001	6.154	5.882	5.566
BEL	2.224	2.311	1.273	4.032	3.63	4.341	6.345	6.025	5.669
BGR	1.188	2.631	2.457	6.431	4.503	4.102	7.695	7.252	6.66
BRA	3.446	3.665	3.703	7.638	7.754	7.948	11.347	11.703	11.945
BWA	3.296	3.241	2.845	6.481	6.586	7.148	9.991	10.04	10.196
CAN	1.603	2.243	1.945	5.64	4.58	4.744	7.334	6.925	6.782
CHE	0.534	0.936	0.426	4.83	4.116	4.384	5.389	5.091	4.83
CHL	2.183	2.435	2.43	7.4	6.99	6.75	9.744	9.595	9.344
CHN	1.518	1.927	2.532	7.04	6.631	6.03	8.665	8.685	8.715
CRI	1.626	2.221	2.285	12.842	12.397	12.316	14.677	14.893	14.883
CUW	1.586	2.584	2.622	5.652	4.673	4.635	7.327	7.377	7.379
CYM	2	3.3	5.7	5.243	3.982	1.734	7.348	7.413	7.533
CYP	0.682	0.782	0.556	8.977	8.017	7.269	9.72	8.862	7.865
CZE	2.451	2.149	2.813	3.715	3.981	3.336	6.257	6.216	6.243
DEU	1.702	1.935	1.289	4.034	3.585	3.935	5.805	5.589	5.274
DNK	1.147	0.814	0.723	4.777	4.842	4.632	5.979	5.695	5.388
ESP	2.036	1.736	0.827	5.351	5.029	5.522	7.496	6.852	6.395
EST	3.651	3.412	2.23	2.976	3.202	4.338	6.735	6.724	6.664
FIN	0.839	1.169	1.179	5.148	4.585	4.303	6.03	5.807	5.532

FRA	1.162	2.099	1.305	5.057	3.839	4.311	6.278	6.019	5.672
GBR	2.691	2.475	1.901	4.22	4.238	4.476	7.025	6.818	6.463
GGY	2.5	2.3	2.4	4.405	4.599	4.502	7.015	7.005	7.01
GRC	1.138	0.774	0.418	12.008	11.201	10.713	13.283	12.062	11.176
HKG	1.481	2.408	2.865	5.271	4.406	3.867	6.83	6.92	6.843
HRV	1.129	1.5	0.772	7.55	6.681	6.868	8.764	8.281	7.693
HUN	2.348	2.85	3.301	6.665	5.613	4.721	9.169	8.624	8.177
IDN	3.809	3.198	3.201	8.616	9.229	9.226	12.753	12.722	12.722
IMN	4.1	2.5	2.1	2.877	4.405	4.794	7.095	7.015	6.995
IND	3.584	3.414	3.482	8.997	9.086	8.709	12.903	12.81	12.495
IRL	0.259	0.716	0.887	6.543	5.44	4.88	6.819	6.196	5.81
ISL	1.76	2.683	3.03	5.906	7.924	7.111	7.77	10.819	10.357
ISR	0.244	0.815	0.878	7.258	6.322	5.977	7.52	7.188	6.908
ITA	1.326	1.243	0.603	6.163	5.909	6.364	7.57	7.226	7.005
JAM	4.388	3.729	3.91	8.36	9.017	8.836	13.115	13.082	13.091
JEY	3.5	3.6	2.3	3.444	5.145	6.417	7.065	8.93	8.865
JPN	0.467	0.988	0.61	4.846	4.204	4.451	5.335	5.234	5.088
KEN	7.985	4.69	5.204	4.762	7.902	7.4	13.128	12.963	12.989
KOR	1.944	1.476	0.283	5.463	5.916	6.82	7.513	7.479	7.122
LIE	0.5	0.9	0.9	4.863	4.467	4.467	5.387	5.408	5.408
LTU	3.718	2.531	2.289	3.303	3.641	3.39	7.144	6.265	5.756
LUX	2.109	2.016	1.695	3.786	3.532	3.557	5.975	5.619	5.312
LVA	2.894	2.554	2.906	3.778	3.629	2.872	6.781	6.276	5.861
MAC	1.228	3.004	2.752	7.332	5.568	5.814	8.65	8.739	8.726
MEX	6.041	4.899	3.546	5.172	6.681	8.329	11.526	11.908	12.171
MLT	1.261	1.741	1.523	5.674	4.851	4.73	7.007	6.677	6.325
MSR	2.248	2.248	2.248	5	5	5	7.36	7.36	7.36
MUS	3.675	3.231	0.454	5.657	6.168	8.791	9.54	9.598	9.285
NLD	1.294	1.601	2.675	4.692	4.12	2.787	6.047	5.787	5.536
NOR	1.883	2.749	2.324	5.041	4.063	4.274	7.019	6.923	6.698
NZL	1.851	1.598	1.549	6.187	6.623	6.149	8.153	8.327	7.793
PER	2.804	1.317	2.136	7.859	9.46	8.455	10.883	10.902	10.772
PNG	5.436	4.674	3.76	9.539	10.799	11.922	15.494	15.978	16.131
POL	2.076	1.813	2.291	6.24	6.337	5.635	8.446	8.265	8.055
PRT	1.556	1.168	0.305	7.286	6.661	6.938	8.956	7.907	7.264
ROU	1.344	4.631	3.825	5.442	1.904	2.532	6.859	6.624	6.454
RUS	3.683	2.878	4.871	10.342	11.626	9.991	14.407	14.839	15.349
SAU	-0.852	2.483	-1.212	7.436	5.456	9.213	6.52	8.074	7.889
SEN	1.143	0.455	1.02	9.957	10.613	9.868	11.214	11.116	10.989
SGP	0.576	0.439	0.565	6.796	6.836	6.627	7.411	7.305	7.229
SVK	1.391	2.533	2.847	5.157	3.564	2.908	6.62	6.187	5.838
SVN	1.557	1.934	1.845	6.014	4.676	4.175	7.664	6.7	6.097
SWE	1.794	1.954	1.779	4.361	3.921	3.762	6.234	5.951	5.607
SYC	2.859	3.699	1.807	7.414	6.884	8.89	10.485	10.838	10.858
TCA	2.1	2.1	2.2	5.145	5.145	5.047	7.353	7.353	7.358
THA	0.665	1.064	0.706	7.296	6.673	6.733	8.009	7.808	7.487
TUR	14.414	14.414	14.414	0.651	0.651	0.651	15.159	15.159	15.159

USA	2.136	2.435	1.783	5.11	4.918	5.481	7.355	7.473	7.361
VGB	1.19	2.1	2.1	6.046	5.145	5.145	7.308	7.353	7.353
ZAF	5.273	4.62	4.189	8.007	8.923	9.511	13.702	13.955	14.098

Note: Long-term interest rates refer to the average of the 5-year prior. The average could refer to fewer number of years if data is missing. When no time series data is available, estimates refer to the average applicable in the year of reference. When neither the time series, nor the point estimate is available, the 2017 value is carried forward to future years as a preliminary estimate. Estimates of the real and nominal interest rates in the table include a 5% risk premium. Inflation rates for Turkey correspond to an average of the years 2017-19 in order to smooth fluctuactions in inflation rates that caused violations in the model conditions. Estimates are not available for Argentina and the Democratic Republic of Congo due to large inflation rates in the years of reference creating large negative real interest rates that are not well captured in modelling assumptions.
Source: For the country-specific scenario, nominal interest and inflation rates are sourced from the OECD Economic Outlook, the IMF International Financial Statistics, the World Bank's World Development Indicators database, the European Central Bank, through direct contact with delegates and from other public sources in a few instances.

6. Asset-specific parameters include the pre-tax rate of return and economic depreciation rates. The pre-tax rate of return is set to 20% throughout all calculations. Economic depreciation rates are based on estimates from the literature (Fraumeni, 1997; BEA, 2003; Patry, 2007; Li, 2012); Table A.4 provides information on asset-specific parameters.

Table A.4. Economic Depreciation by Asset Category

Asset	Economic Depreciation
Non-residential Structures	0.0269
Tangible Assets	0.1476
Intangible Assets	0.2548

Note: The economic depreciation of tangible assets is calculated as the weighted-average of the economic depreciation of movable and immovable tangible assets (estimated at 16.08% and 11.45%) using as a benchmark their proportion in 2018 US capital stocks (71:28 split for movable and immovable tangible assets).
Source: Fraumeni, 1997; BEA, 2003; Patry, 2007; Li, 2012; Secretariat calculations.

7. Tax-related parameters are collected via the annual OECD Corporate Effective Tax Rates survey filled in by country delegates from the Working Party No 2 on Tax Policy and Statistics. Data for EU-28 countries in 2017 was collected by the Centre for European Economic Research (ZEW) at the request of the European Commission (EC) and has been validated by country delegates to ensure the consistency of the two approaches.

8. Some countries had an allowance for corporate equity (ACE) in place in the reference period. In scenarios 1 and 2, interest and inflation are constant across countries; in these two cases, it is assumed that notional interest deductions are equal to the nominal interest rate consistent with the modelling assumptions, i.e. 7.1% and 4.03% in the first and second scenario, respectively. For Liechtenstein the calculations also account for a 6% reduction of the equity stock applicable for the calculation of the notional interest deduction. Similarly, the relevant equity stock is reduced by 50% in Turkey according to the relevant tax provisions. In Italy, the ACE does not apply for purposes of the local profits tax (IRAP); this effect is accounted for by including the relevant tax rate in equation (29) of Annex B. In 2018, the notional interest deduction (NID) in Belgium was reformed to apply only to the incremental net accounting equity over a period of five years. The smoothing of the benefits of the provisions over a given number of years is modelled by the parameter N^{ACE} in equation (29) in Annex B. This parameter takes the value 1 for the rest of NID cases.

9. In the country-specific scenario, notional interest deductions correspond to the actual rates that have been legislated in the respective years (see Table A.5).

Table A.5 Notional Interest Deduction (%)

Country Code	Year	Scenario 1	Scenario 2	Scenario 3
BEL	2017	7.1	4.03	0.237
BEL	2018	7.1	4.03	0.746
BEL	2019	7.1	4.03	0.726
BRA	2017	7.1	4.03	7.13
BRA	2018	7.1	4.03	6.72
BRA	2019	7.1	4.03	6.2
CYP	2017	7.1	4.03	6.489
CYP	2018	7.1	4.03	4.881
CYP	2019	7.1	4.03	4.881
ITA	2017	7.1	4.03	1.6
ITA	2018	7.1	4.03	1.5
ITA	2019	7.1	4.03	1.3
LIE	2017	6.674	3.7882	3.76
LIE	2018	6.674	3.7882	3.76
LIE	2019	6.674	3.7882	3.76
MLT	2017	0	0	0
MLT	2018	7.1	4.03	7.0025
MLT	2019	7.1	4.03	6.1375
POL	2017	0	0	0
POL	2018	0	0	0
POL	2019	7.1	4.03	2.5
PRT	2017	7.1	4.03	7
PRT	2018	7.1	4.03	7
PRT	2019	7.1	4.03	7
TUR	2017	3.55	2.015	8.53
TUR	2018	3.55	2.015	13.52
TUR	2019	3.55	2.015	6.01

Note: The NID for Turkey and Liechtenstein reflect the adjusted rate.
Source: Secretariat.

10. Expensing investments implies that investment costs can be deducted immediately, i.e., at the beginning of the first period of the project lifetime. Since this reduces financing costs in the case of debt finance, equation (11b) accounts for this effect by including a parameter capturing the share of expensing or bonus depreciation available. However, this effect does not occur when investments are depreciated, e.g., based on a 100% SL or DB schedule; those cases correspond to situations where deductions become available at the end of the first year, thus not having any impact on the amount of debt that needs to be taken up. As opposed to expensing, when the asset is depreciated over time, the net present value of depreciation allowances is lower, due to the impact on inflation. The reduction in the value of the investment caused by inflation is therefore sensitive to the life of the asset. In order to compensate for this loss in value, some jurisdictions index depreciation allowances by inflation. This includes Chile, Costa Rica, Iceland, Mexico, the Netherlands, Romania, Senegal and Turkey for years 2017-19; and for Argentina for 2018-19. This is accounted for in the modelling of ETRs as per Annex B – see Fiscal Depreciation.

11. Estonia and Latvia from 2018 tax corporate profits only if they are distributed; retained profits are not taxed. Following ZEW (2016), the effects of this system are accounted for by modifying the parameter measuring the opportunity cost of retained earnings in terms of dividends foregone (γ). Since personal income taxes are not included in the present analysis, this parameter is equal to one throughout the rest of the analysis; however, for Estonia and Latvia it is set to $(1-\tau_d)/(1-\tau)$, implying that the opportunity cost of retained earnings is reduced to 80% when the distribution system is in place, being the standard rate, τ, equal to 0% and the rate on distributions, τ_d, equal to 20%.

Asset Categories and Construction of Composite ETRs

12. In the CTPA questionnaire, the four asset categories were defined as follows.

- **Non-residential structures**: e.g., office buildings or plants.
- **Tangible assets**: e.g., machinery, cars, furniture or equipment..
- **Intangible assets**: e.g., acquired patents, trade-marks or utility models.
- **Inventories**

13. The questionnaire described the most common cost recovery methods, provided examples and asked respondents to provide information on the most empirically relevant tax depreciation rules within a given asset category. For countries with more fine-grained, differentiated tax depreciation rules, additional information on asset stocks within each category was provided (based on US data from 2018), to inform the choice of the appropriate tax depreciation rule.

14. Using this information, ETRs are calculated separately for each asset and source of finance, i.e., debt and equity. Asset-specific ETRs, depicted in Figure 1.3, are calculated by weighting debt to equity using a 35:65 split, as is common in the empirical literature (e.g., Egger et al., 2009). The composite ETRs are then constructed as an unweighted average across the four asset categories.

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Annex A. Equations

Main Equations

$$EATR = \frac{R^* - R}{p/(1+r)} \tag{1}$$

$$R^* = \ (p-r)/(1+r) \tag{-}$$

$$R^{RE} = -(1-A) + \frac{1}{1+i}[(p+\delta)(1+\pi)(1-\tau) + (1-\delta)(1+\pi)(1-A)] \tag{9}$$

$$R = R^{RE} + F^{DE} + F_{ACE} \tag{11a}$$

$$F^{DE} = \begin{cases} \frac{(1-\tau * \varphi_{exp})}{1+i}(i - i(1-\tau)) & Debt \\ 0 & Retained\ Earnings \end{cases} \tag{11b}$$

$$\tilde{p} = \frac{(1-A)(i+\delta(1+\pi)-\pi)}{(1+\pi)(1-\tau)} - \frac{F^{DE}(1+i)}{(1-\tau)(1+\pi)} - \delta \tag{13}$$

$$EMTR = \frac{\tilde{p} - r}{\tilde{p}} \tag{14}$$

Fiscal Depreciation

$$A^{DB} = \frac{\tau\varphi}{1+i}\left[1 + \left(\frac{1-\varphi}{1+i}\right) + \left(\frac{1-\varphi}{1+i}\right)^2 + \left(\frac{1-\varphi}{1+i}\right)^3 + \cdots\right] = \frac{\tau\varphi}{\varphi+i} \tag{16}$$

$$A^{SL} = \tau\varphi\left[\left(\frac{1}{1+i}\right) + \left(\frac{1}{1+i}\right)^2 + \cdots + \left(\frac{1}{1+i}\right)^T\right] = \frac{\tau\varphi}{i}\left(1 - (1+i)^{-\frac{1}{\varphi}}\right) \tag{17}$$

$$A^{DBSL} = \tau\left[\frac{\beta}{1+i}\left(1 + \frac{(1-\beta)}{(1+i)} + \frac{(1-\beta)^2}{(1+i)^2} + \cdots + \frac{(1-\beta)^{T^*-1}}{(1+i)^{T^*-1}}\right) + \frac{(1-\beta)^{T^*}}{(T-T^*)}\left(\frac{1}{(1+i)^{T^*+1}} + \cdots + \frac{1}{(1+i)^T}\right)\right] \tag{18}$$

$$A_{HYC}^{DBSL} = \tau\left[\frac{\beta}{1+i}\left(\frac{1}{2}+\frac{(1-\beta/2)}{(1+i)}+\frac{(1-\beta/2)(1-\beta)}{(1+i)^2}+\frac{(1-\beta/2)(1-\beta)^2}{(1+i)^3}+\cdots\right.\right.$$
$$\left.+\frac{(1-\beta/2)(1-\beta)^{T^*-2}}{(1+i)^{T^*-1}}\right)$$
$$+\frac{(1-\beta/2)(1-\beta)^{T^*-1}}{(T-T^*)}\left(\frac{1}{(1+i)^{T^*+1}}+\cdots+\frac{1}{(1+i)^T}\right.$$
$$\left.\left.+\frac{1}{2}\frac{1}{(1+i)^{T+1}}\right)\right] \tag{19}$$

When depreciation allowances are indexed by inflation, the net present value is calculated as above but using the real interest rate in (16)-(19) as the discount factor.

Inventory Valuation

$$R_v^{RE} = -(1-A)+\frac{1}{1+i}[(p+\delta)(1+\pi)(1-\tau)-v\pi\tau+(1-\delta)(1+\pi)(1-A)] \tag{26}$$

$$\widetilde{p_v} = \frac{(1-A)(i+\delta(1+\pi)-\pi)+v\pi\tau}{(1+\pi)(1-\tau)}-\frac{F^{DE}(1+i)}{(1-\tau)(1+\pi)}-\delta \tag{27}$$

Allowance for Corporate Equity

$$F_{ACE} = \begin{cases} 0 & Debt \\ \hat{\imath}(\tau-\hat{\tau})*\left(\frac{1}{N^{ACE}*i}\right)\left(1-\left(\frac{1}{1+i}\right)^{N^{ACE}}\right) & Retained\ Earnings \end{cases} \tag{29}$$