CORPORATE TAX STATISTICS

Corporate Effective Tax Rates: Explanatory Annex

(Annex applicable for corporate effective tax rates 2021)

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); 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	$r\gtrless 0$	(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 two different macroeconomic scenarios. In the first scenario, 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 second scenario, country-specific macroeconomic parameters are set to be country-specific. For this ccenario, 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 contradict the definition of the tax-inclusive EMTR.

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)	1	3	4.03
2	(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 2

Country Code	Inflation (%)					Real interest rate (%)					Nominal interest rate (%)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
AGO	29.8	19.6	17.1	22.3	25.77	-11.9	-5.2	-3.5	-7.5	-9.6	14.4	13.4	13.0	13.1	13.6
ALB	2.0	2.0	1.4	1.6	2.04	4.8	4.5	4.7	4.5	4.3	6.9	6.5	6.2	6.2	6.5
AND	2.4	0.7	1.0	1.0	1.74	4.4	5.7	5.2	5.1	4.6	6.9	6.5	6.2	6.2	6.5
ARG	25.7	34.3	53.5	42.0	48.41	-9.1	-14.7	-22.5	-16.6	-21.2	14.2	14.5	19.0	18.5	17.0
AUS	2.0	1.9	1.6	0.9	2.82	6.0	5.9	5.8	6.1	3.7	8.1	7.9	7.5	7.1	6.6
AUT	2.2	2.1	1.5	1.4	2.75	3.8	3.7	4.0	3.9	2.2	6.2	5.9	5.6	5.4	5.1
BEL	2.2	2.3	1.2	0.4	3.22	4.0	3.6	4.4	5.0	1.9	6.3	6.0	5.7	5.4	5.1
BGR	1.2	2.6	2.5	1.2	2.84	6.4	4.5	4.1	4.9	2.4	7.7	7.3	6.7	6.2	5.3
BRA	2.9	3.7	4.3	4.5	8.30	11.8	7.6	6.6	3.3	1.8	15.1	11.6	11.2	8.0	10.2
BWA	3.3	3.2	2.8	2.0	6.68	6.5	6.6	7.1	8.3	5.7	10.0	10.0	10.2	10.4	12.7
CAN	1.6	2.3	1.9	0.7	3.40	5.2	4.6	4.7	5.8	3.0	6.9	6.9	6.8	6.6	6.5
CHE	0.5	0.9	0.4	-0.7	0.58	4.7	4.1	4.4	5.4	4.2	5.3	5.1	4.8	4.7	4.8
CHL	2.2	2.3	2.3	3.0	7.20	7.4	7.1	6.9	5.8	2.4	9.7	9.6	9.4	9.1	9.7
CHN	1.6	2.1	2.9	2.4	0.85	7.0	5.3	4.6	5.1	7.1	8.7	7.5	7.6	7.6	8.1
COD	35.8	29.3	4.7	11.3	8.99	-15.7	-11.7	7.9	1.7	3.8	14.5	14.2	13.0	13.3	13.2
COL	4.3	3.2	3.5	2.5	3.50	7.8	9.0	8.6	9.3	9.0	12.4	12.5	12.4	12.0	12.8
CRI	1.6	2.2	2.1	0.7	1.73	12.8	12.4	12.7	14.1	10.4	14.7	14.9	15.0	14.9	12.3
CUW	2.7	2.5	1.8	0.9	4.80	4.6	4.9	5.5	6.2	1.8	7.4	7.5	7.4	7.1	6.7
CYM	2.7	2.5	1.8	0.9	4.80	4.6	4.9	5.5	6.2	1.8	7.4	7.5	7.4	7.1	6.7
CYP	0.7	0.8	0.6	-1.1	1.92	9.0	8.0	7.3	8.2	3.5	9.7	8.9	7.9	7.1	5.5
CZE	2.5	2.1	2.8	3.2	3.84	3.7	4.0	3.3	3.1	3.1	6.3	6.2	6.2	6.4	7.1
DEU	1.7	1.9	1.4	0.4	3.21	4.0	3.6	3.9	4.6	1.5	5.8	5.6	5.3	5.0	4.8
DNK	1.1	0.7	0.7	0.3	1.85	4.9	4.9	4.6	4.8	3.1	6.0	5.7	5.4	5.2	5.0
ESP	2.0	1.7	0.7	-0.3	3.09	5.4	5.1	5.6	6.4	2.3	7.5	6.8	6.4	6.1	5.5
EST	3.7	3.4	2.3	-0.6	4.49	3.2	3.1	3.9	6.8	0.8	6.9	6.6	6.3	6.1	5.3
FIN	0.8	1.2	1.1	0.4	2.07	5.1	4.6	4.3	4.9	2.9	6.0	5.8	5.5	5.3	5.0
FRA	1.2	2.1	1.3	0.5	2.06	5.0	3.8	4.3	4.9	3.0	6.3	6.0	5.7	5.4	5.1
GBR	2.7	2.5	1.8	0.9	2.59	4.2	4.2	4.6	5.2	3.2	7.0	6.8	6.5	6.1	5.9
GGY	2.7	2.5	1.8	0.9	2.59	4.2	4.2	4.6	5.2	3.2	7.0	6.8	6.5	6.1	5.9
GRC	1.1	0.8	0.5	-1.3	0.57	12.0	11.2	10.6	10.8	5.3	13.3	12.1	11.2	9.4	5.9
HKG	1.5	2.4	2.9	0.3	1.57	5.3	4.4	3.9	6.4	5.2	6.8	6.9	6.8	6.7	6.8
HRV	1.1	1.5	0.8	0.3	2.61	5.6	5.0	5.4	5.9	3.8	6.8	6.5	6.2	6.1	6.5
HUN	2.4	2.8	3.4	3.3	5.12	6.6	5.6	4.7	4.5	3.0	9.2	8.6	8.2	7.9	8.3
IDN	3.8	3.3	2.8	2.0	1.56	3.1	3.5	3.6	4.3	9.7	7.1	6.9	6.5	6.5	11.4
IMN	2.7	2.5	1.8	0.9	2.59	4.2	4.2	4.6	5.2	3.2	7.0	6.8	6.5	6.1	5.9

IND	3.6	3.4	4.8	6.2	5.52	9.0	9.1	7.4	5.8	5.7	12.9	12.8	12.6	12.3	11.5
IRL	0.3	0.7	0.9	-0.5	2.41	6.5	5.5	4.9	6.0	2.7	6.8	6.2	5.8	5.5	5.2
ISL	1.8	2.7	3.0	2.9	4.44	8.9	7.9	7.1	6.6	4.0	10.9	10.8	10.4	9.6	8.6
ISR	0.2	0.8	0.8	-0.6	1.49	7.3	6.3	6.0	7.2	4.6	7.5	7.2	6.9	6.6	6.2
ITA	1.3	1.2	0.6	-0.1	1.94	6.2	5.9	6.3	7.0	3.9	7.6	7.2	7.0	6.9	5.9
JAM	4.4	3.7	3.9	5.2	5.90	8.4	9.0	8.8	7.6	6.9	13.1	13.1	13.1	13.2	13.2
JEY	2.7	2.5	1.8	0.9	2.59	4.2	4.2	4.6	5.2	3.2	7.0	6.8	6.5	6.1	5.9
JPN	0.5	1.0	0.5	0.0	-0.25	4.8	4.2	4.6	5.0	5.3	5.3	5.2	5.1	5.0	5.1
KEN	8.0	4.7	5.2	5.3	6.11	4.8	7.9	7.4	7.3	6.5	13.1	13.0	13.0	13.0	13.0
KOR	1.9	1.5	0.4	0.5	2.50	5.6	5.9	6.7	6.4	4.6	7.7	7.5	7.1	7.0	7.2
LIE	0.5	1.0	0.3	-0.7	0.58	4.7	4.1	4.5	5.4	4.4	5.3	5.1	4.8	4.7	5.0
LTU	3.7	2.5	2.2	1.1	4.63	3.2	3.6	3.4	4.4	0.7	7.0	6.3	5.8	5.5	5.4
LUX	2.1	2.0	1.7	0.0	3.47	3.7	3.5	3.6	5.1	1.3	5.9	5.6	5.3	5.1	4.8
LVA	2.9	2.6	2.7	0.1	3.24	3.8	3.6	3.0	5.4	1.9	6.8	6.3	5.9	5.5	5.2
MAC	1.2	3.0	2.8	0.8	0.03	5.5	3.8	4.0	5.9	6.7	6.8	7.0	6.8	6.7	6.7
MEX	6.0	4.9	3.6	3.4	5.69	5.2	6.7	8.2	8.5	6.0	11.5	11.9	12.2	12.2	12.0
MLT	1.3	1.7	1.5	0.8	0.71	5.7	4.9	4.7	5.3	5.6	7.0	6.7	6.3	6.2	6.4
MSR	2.1	2.4	1.8	1.2	2.99	5.1	4.9	5.5	5.8	4.3	7.3	7.5	7.4	7.1	7.4
MUS	3.7	3.2	0.5	2.5	4.04	5.7	6.2	8.8	6.7	3.4	9.5	9.6	9.3	9.4	7.6
NLD	1.3	1.6	2.7	1.1	2.83	4.7	4.1	2.8	4.1	1.9	6.0	5.8	5.5	5.2	4.8
NOR	1.9	2.8	2.2	1.3	3.48	5.0	4.0	4.4	5.1	3.0	7.0	6.9	6.7	6.5	6.6
NZL	1.9	1.6	1.6	1.7	3.94	6.6	6.6	6.1	5.5	3.0	8.6	8.3	7.8	7.3	7.0
PER	2.8	1.3	2.1	1.8	6.43	7.9	9.5	8.5	8.8	3.7	10.9	10.9	10.8	10.8	10.4
PNG	5.4	4.7	3.7	5.0	4.49	9.5	10.9	12.0	10.8	11.0	15.5	16.1	16.2	16.3	16.0
POL	2.0	1.6	2.3	3.4	5.06	6.3	6.5	5.6	4.3	2.0	8.4	8.3	8.1	7.9	7.2
PRT	1.6	1.2	0.3	-0.1	0.94	7.1	6.7	6.9	7.0	4.4	8.8	7.9	7.3	6.8	5.3
ROU	1.3	4.6	3.8	2.6	5.05	5.4	1.9	2.5	3.9	1.6	6.9	6.6	6.5	6.7	6.7
SAU	-0.8	2.5	-2.1	3.4	3.06	7.4	5.5	10.1	4.5	4.6	6.5	8.1	7.8	8.1	7.8
SEN	1.1	0.5	1.0	2.5	2.20	10.0	10.6	9.9	8.4	8.7	11.2	11.1	11.0	11.1	11.1
SGP	0.6	0.4	0.6	-0.2	2.31	6.6	6.8	6.6	7.1	4.1	7.2	7.3	7.2	6.9	6.5
SVK	1.4	2.5	2.8	2.0	2.83	5.1	3.6	3.0	3.5	2.2	6.6	6.2	5.8	5.6	5.1
SVN	1.4	1.7	1.6	-0.1	1.91	6.1	4.9	4.4	5.7	3.2	7.7	6.7	6.1	5.7	5.2
SWE	1.9	2.0	1.6	0.7	2.16	4.3	3.8	3.9	4.7	3.1	6.2	6.0	5.6	5.4	5.4
SWZ	6.1	5.9	5.3	5.3	5.64	8.2	8.7	9.6	9.4	8.9	14.7	15.1	15.4	15.1	15.1
SYC	2.9	3.7	1.8	1.2	9.77	7.6	6.9	8.9	9.9	3.5	10.6	10.8	10.9	11.2	13.6
TCA	2.1	2.4	1.8	1.2	4.69	5.1	4.9	5.5	5.8	1.9	7.3	7.5	7.4	7.1	6.7
THA	0.7	1.1	0.7	-0.8	1.23	7.3	6.7	6.7	8.0	5.5	8.0	7.8	7.5	7.1	6.8
TUR	11.1	16.3	15.2	12.3	19.60	3.5	-0.9	0.0	2.5	-3.5	15.0	15.3	15.2	15.1	15.4
USA	2.1	2.4	1.8	1.2	4.69	5.1	4.9	5.5	5.8	1.9	7.3	7.5	7.4	7.1	6.7
VGB	2.1	2.4	1.8	1.2	4.69	5.1	4.9	5.5	5.8	1.9	7.3	7.5	7.4	7.1	6.7
ZAF	5.3	4.6	4.1	3.3	4.56	8.0	8.9	9.6	10.8	10.0	13.7	14.0	14.1	14.4	15.0

Note: Long-term interest rates refer to the average of the 5-year prior. The average could refer to fewer numbers 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. In Scenario 2, ETR indicators are not available for four countries (Angola, Argentina, the Democratic Republic of Congo and Turkey) due to large inflation rates in the years of reference creating large negative real interest rates that are inconsistent with standard 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). Starting with the 3rd edition of CTS, the data collection for the tangible asset category is disaggregated into five subgroups (air, rail or water transport vehicles, computer hardware, equipment, industrial machinery, roadtransport vehicles) to better match variation in economic depreciation rates within this asset category. Table A.4 provides information on asset-specific parameters.

Table A.4. Economic Depreciation by Asset Category

Asset	Economic Depreciation
Non-residential Structures	0.0329
Air, Rail or Water Transport Vehicles (Tangible Asset)	0.0661
Computer Hardware (Tangible Asset)	0.3699
Equipment (Tangible Asset)	0.1546
Industrial Machinery (Tangible Asset)	0.1259
Road Transport Vehicles (Tangible Asset)	0.2014
Acquired Software	0.4033

Note: The tangible assets category consists of five subgroups (air, rail or water transport vehicles, computer hardware, equipment, industrial machinery, roadtransport vehicles) that are aggregated, using the unweighted average, to obtain a single set of ETR indicators for this category.
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 scenario 1, interest and inflation are constant across countries; in this case, it is assumed that notional interest deductions are equal to the nominal interest rate consistent with the modelling assumptions, i.e. 4.03%. 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
BEL	2017	4.03	0.237
BEL	2018	4.03	0.746
BEL	2019	4.03	0.726
BEL	2020	4.03	0.0
BEL	2021	4.03	0.0
CYP	2017	4.03	6.489
CYP	2018	4.03	4.881
CYP	2019	4.03	4.881
CYP	2020	4.03	5.136
CYP	2021	4.03	5.36
ITA	2017	4.03	1.6
ITA	2018	4.03	1.5
ITA	2019	4.03	1.3
ITA	2020	4.03	1.3
ITA	2021	4.03	0.81
LIE	2017	3.7882	3.76
LIE	2018	3.7882	3.76
LIE	2019	3.7882	3.76
LIE	2020	3.7882	3.76
LIE	2021	3.7882	3.76
MLT	2017	0.0	0.0
MLT	2018	4.03	7.0025
MLT	2019	4.03	6.1375
MLT	2020	4.03	6.16
MLT	2021	4.03	6.3275
POL	2017	0.0	0.0
POL	2018	0.0	0.0
POL	2019	4.03	2.5
POL	2020	4.03	2.5
POL	2021	4.03	1.94
PRT	2017	4.03	7.0
PRT	2018	4.03	7.0
PRT	2019	4.03	7.0
PRT	2020	4.03	7.0
PRT	2021	4.03	7.0
TUR	2017	2.015	8.53
TUR	2018	2.015	13.52
TUR	2019	2.015	6.01
TUR	2020	2.015	6.01
TUR	2021	2.015	12.19

Notes: The NID for Turkey and Liechtenstein reflect the adjusted rate. The legislated 15% NID for Italy in 2021 falls beyond the nominal interest rate and cannot be captured by the Secretariat's methodology. As a result, the NID was adjusted to 0.81% (the long-term government interest rate in 2021).
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 2017-21; and for Argentina for 2018-20.

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 OECD Corporate Effective Tax Rate survey, the four asset categories were defined as follows.

- **Non-residential structures**: (1) manufacturing plants, large engineering structures, office or commercial buildings..
- **Tangible assets**: (1) road transport vehicles, (2) air, rail or water transport vehicles, (3) computer hardware, (4) equipment and (5) industrial machinery.
- **Acquired intangible assets**: (1) acquired software.
- **Inventories**

13. The survey described the most common cost recovery methods, provided examples and asked respondents to provide information on the tax depreciation rules corresponding to a given asset group (e.g., computer hardware or manufacturing plants.

14. Using this information, ETRs are calculated separately for each asset and source of finance, i.e., debt and equity. Asset-specific ETRs 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). ETRs for the tangible asset category, published in the CTS database, are then constructed as an unweighted average over the respective value for each of the five subgroups.The composite ETRs are then constructed as an unweighted average across the four asset categories.

References

BEA (2003), Fixed Assets and Consumer Durable Goods in the United States, 1925-1997, US Bureau of Economic Analysis.

Devereux, Michael P., and Rachel Griffith (1999), The Taxation of Discrete Investment Choices, Institute for Fiscal Studies, Working Paper Series No. W98/16.

Devereux, Michael P., and Rachel Griffith (2003), Evaluating Tax Policy for Location Decisions, International Tax and Public Finance, Vol. 10, pages 107–126.

Egger, Peter, Simon Loretz, Michael Pfaffermayr and Hannes Winner (2009), Bilateral Effective Tax Rates and Foreign Direct Investment, International Tax and Public Finance, Vol. 16, pages 822-849.

Fraumeni, Barbara, (1997), The Measurement of Depreciation in the U.S. National Income and Product Accounts, Survey of Current Business.

Hanappi, T. (2018), "Corporate Effective Tax Rates: Model Description and Results from 36 OECD and Non-OECD Countries", OECD Taxation Working Papers, No. 38, OECD Publishing, Paris, http://dx.doi.org/10.1787/a07f9958-en.

Li, Wendy C.Y., (2012), Depreciation of Business R&D Capital, Bureau of Economic Analysis/National Science Foundation, R&D Satellite Account Paper.

Patry, Andre, (2007), Economic Depreciation and Retirement of Canadian Assets: A Comprehensive Empirical Study, Statistics Canada, Catalogue No. 15-549-XIE

ZEW (2016), Project for the EU Commission: Effective Tax Levels using the Devereux/Griffith Methodology, Zentrum fuer Europaeische Wirtschaftsforschung, Project for the EU Commission, TAXUD/2013/CC/120, Final Report.

Annex A. Equations

Main Equations

$$EATR = \frac{R^* - R}{Y^*} \tag{1}$$

$$R^* = -1 + \sum_{s=0}^{\infty} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-1}}{(1+i)^s} = \frac{p-r}{r+\delta} \tag{-}$$

$$Y^* = \sum_{s=0}^{\infty} \frac{p(1+\pi)^s(1-\delta)^{s-1}}{(1+i)^s} = \frac{p}{r+\delta} \tag{-}$$

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

$$F = F^{DE} + F_{ACE}^{RE} \tag{-}$$

$$R^{RE} = -(1-\boldsymbol{A}) + \sum_{s=0}^{\infty} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-1}(1-\bar{\tau})}{(1+i)^s} = -(1-\boldsymbol{A}) + \frac{(p+\delta)(1-\bar{\tau})}{r+\delta} \tag{9}$$

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

$$F_{ACE}^{RE} = \begin{cases} \hat{\imath}(\tau-\hat{\tau})\dfrac{1}{(r+\delta)(1+\pi)} & ACE - Equity\ Stock \\ \hat{\imath}(\tau-\hat{\tau})\dfrac{1}{(1+i)} & ACE - New\ Equity \\ 0 & Debt \end{cases} \tag{29}$$

$$\tilde{p} = \frac{(1-A)(r+\delta)}{(1-\tau)} - \frac{F(r+\delta)}{(1-\tau)} - \delta \tag{13}$$

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

Fiscal Depreciation

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

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

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

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

Note: 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

$$R_v^{RE} = -(1-A) + \frac{(p+\delta)(1-\bar{\tau})}{r+\delta} - \nu\tau\frac{(1+\pi)}{r(1+\pi)} \tag{26}$$

$$\widetilde{p_v} = \frac{(1-A)(r+\delta)}{(1-\tau)} + \frac{\nu\tau\pi(r+\delta)}{r(1+\pi)(1-\tau)} - \frac{F(r+\delta)}{(1-\tau)} - \delta \tag{27}$$