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The Relevance of Depreciation Allowances as a Fiscal Policy Instrument: A Hybrid Approach to CCCTB?

by

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Abstract

A major goal of the EU Commission in the area of direct taxation is the introduction of a common consolidated corporate tax base (CCCTB) in Europe. While hardly discussed in the literature, such a system would limit national discretion over tax depreciation. In a sample of up to 47 countries, we find that the probability of a tax reform that improves the depreciation allowances increases, if the macroeconomic situation is weak. This suggests that changes in depreciation allowances are used as a fiscal instrument for stabilization. A common consolidated tax base deprives national governments from implementing investment incentives via accelerated depreciation. This paper discusses the possible implementation of a hybrid system that combines features of formula apportionment and separate accounting. Such a hybrid system may substantially mitigate transfer pricing problems and other tax planning issues, whilst preserving national discretion over depreciation allowances.

Keywords: CCCTB, corporate taxation, investment incentives, macro fiscal policy.

JEL classification: H2

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1 Introduction

A major goal of the EU Commission in the area of direct taxation is the introduction of a common consolidated corporate tax base (CCCTB) in Europe. The introduction of a CCCTB could end 27 different definitions of the corporate tax base within the EU, leading to a significant simplification for European multinational firms. Together with the consolidation of European profits, it would allow for cross-border loss offsets and would significantly reduce the opportunities of multinational firms for tax planning.

Over the last years, various approaches for a comprehensive tax system in Europe have been discussed (Bettendorf, Devereux, van der Horst, de Mooij, 2010), but eventually one stood up above the others: the Common Consolidated Corporate Tax Base (CCCTB). In order to develop a concrete design of the CCCTB, a special working group was established, and it has subsequently published more than 60 working papers. Finally, on the 16th of March in 2011, the European Commission adopted a proposal for a Council Directive for a European CCCTB and forwarded it to the Council, the European Parliament and to all national parliaments (Vascega and van Thiel, 2011). In such a CCCTB system, the tax base of European company groups would be uniformly defined and individual member countries that host parts of the company group would receive parts of the consolidated tax base based on formula apportionment (FA). The formula of the draft directive puts a third of its weight on sales, a third on tangible assets, and payroll and the number of employees would receive the weight one sixth, each. However, political progress towards FA and CCCTB remains difficult to achieve and separate accounting (SA) continues to prevail. Under SA, each member state uses its own definition of corporate profits and the arm's length principle is used to allocate corporate profits between affiliated corporations.

As a reaction to the difficult political process of arriving at an agreed upon FA, the commission presented a new draft directive in autumn 2016. The new proposal contains a two-step design. A first step implies compulsory harmonized corporate tax base for company groups in the EU. Only a later second step would introduce formula apportionment (EU Commission, 2016).

In a globalized world with more and more multinational activities, the current arm's length principle, according to which the taxable profit of each affiliate of a corporate group is calculated separately, is increasingly difficult to apply. Between affiliates of a company group, all kinds of transactions occur, such as payments for intellectual property, interest on intra-company loans, sales of intermediate and finished goods, etc. The arm's length principle introduces the assumption that for tax purposes the correct fees and transfer prices are the ones that would have been agreed on by independent companies. Yet, in practice, multinational activity is often connected to special advantages not available to stand-alone firms and recent theoretical and empirical contributions to international trade suggest that

multinational firms are systematically more productive than domestic firms. These factors aggravate the problem of using the arm's length benchmark.

Within Europe, a CCCTB with FA would reduce multinational firms' incentive to shift corporate income from high-tax to low-tax countries in order to reduce their overall tax burden (Hines, 1999; Clausing, 2003). Groups of companies that are taxed on a consolidated basis would lose the incentive to use tax minimizing financial structures, use license fees to reduce taxable profits in high-tax jurisdictions, or misprice their intra-company sales of intermediate goods.[1]

At the same time, FA could increase the distortions created by tax rate differentials. Multinationals face an incentive to shift factors, which enter the formula that apportions the total company tax base to participating countries, to low-tax jurisdictions. Whereas under SA tax rate differentials may create more distortions in the financial sphere (transfer prices, financial structure), under FA they may create more distortions for real economic variables. In particular, they may distort the location of capital and employees as well as the ownership structure of firms.

This paper discusses a method to strike a balance between national sovereignty and subsidiarity, on the one hand, and the coordination of corporate taxes to limit profit shifting, tax avoidance, and administrative costs, on the other hand. It proposes and discusses a hybrid system that combines features of FA and SA.

Essentially, the profit of a corporation consists of different categories of both income and costs. Different categories of income may be defined as sales income, interest income, patent income, income from leasing etc. Total cost can be decomposed into costs associated with wages, physical intermediates, interest, depreciation, consultancy, use of intellectual property, provisions for deferred wages, etc. We show that, in principle, for each of these income and cost categories, there is a possible choice between either allowing a national definition or switching to a common EU definition. If cost and income categories with national definitions are allocated based on SA, while cost and income categories that receive a harmonized EU definition are allocated using FA, a gradual move from one system to the other is possible, eventually resulting in a hybrid system. A main objective of the paper is to lay out how such a hybrid approach may work, in which some costs (e.g., depreciation) are exempted from FA and continue to be nationally defined.

Such a gradual or hybrid approach may not only facilitate political support by allowing time to better understand FA, but may also have economic advantages if there are trade-offs that affect the net benefits of FA differently for various categories of incomes and cost. For example, the abolition of national depreciation rules in a currency union may deprive national governments of a potentially useful

[1] There is debate about the extent to which FA reduces tax competition in tax rates. See, e.g., Pethig and Wagener (2007).

policy instrument to stimulate the economy, whereas accepting a uniform EU definition of patent income, may have a comparatively lower cost.

Indeed, several EU member states have provided more generous allowances for investment during the financial crisis. Austria introduced a special 30% allowance for investments purchased in 2009 and 2010. For the years 2009 and 2010, Germany allowed the use of a 25% geometric depreciation instead of the flat line depreciation that had been laid down shortly before in the tax reform act 2008. Also, Latvia increased the asset value for depreciation purposes, and France increased its maximum rate for declining-balance depreciation. Furthermore, in order to boost investment, Finland introduced temporary accelerated depreciations that were in force in 2009 and 2010; during this period firms could deduct depreciation allowances calculated at a rate that was double the standard rate.[2]

Switching over to strict FA would take away national discretion in setting depreciation allowances. This has been discussed in selected contributions. Kiesewetter, Steigenberger and Stier (2014, p. 4) think that for political reasons a "substantial number of national tax allowances and incentives are highly likely to survive the harmonization of the tax base". Gammy et al. (2005, p. 17) recognize that the corporate tax and its depreciation allowances may be used as a policy tool to stimulate investment, but do not discuss the problems that may come with giving up this tool.

Empirically, accelerated depreciation has been shown to be a powerful tool to spur investment (Ohrn, 2016). Against this background, one question addressed in this paper is the question of whether a loss of discretion comes at an economic cost. For this reason, the paper reviews changes of depreciation allowances in the past. To make the case that, in the past, depreciation allowances empirically have been influenced by the macroeconomic situation we start with an empirical section. Within a panel data set for up to 47 countries, Section 2 of the paper provides evidence that in the past governments were more likely to improve allowances when the macro economy was weak. This finding suggests that the measure has been used as a fiscal instrument to stimulate the economy. Motivated by this observation, a further question is whether the implementation of a hybrid system, in which depreciation may still be set on the national level, could be a solution. In principle, numerous hybrid systems could be devised as a multinational firm's pre-tax profit can be thought of as a sum of different revenue and loss categories and each category could be either left to national taxation or joint taxation. Thus, linear combinations between formula apportionment and separate accounting are worth considering. Section 3 discusses the implications for the cost of capital in a particular hybrid system, in which national investment incentives prevail. Section 4 provides a

[2] 2*25% = 50% for machinery and 2*7% = 14% for industrial buildings. From 2012 to 2016, Finland reintroduced accelerated depreciation allowances.

discussion of alternatives to national depreciation allowances in a formula apportionment system. Section 5 provides concluding remarks.

2 Changes of Depreciation Allowances in the Past

While the common monetary policy suggests an increased role for national fiscal policies, the harmonization of depreciation allowances across member states would take away an instrument that may be useful to react to asymmetric shocks. Whether the loss of national depreciation rules comes at a cost depends on the extent to which governments, if allowed, are indeed using this instrument for discretionary fiscal policy. The more frequently countries are using changes in depreciation allowances as an instrument of fiscal policy, the greater the potential loss from harmonization may be. Conversely, if changes in the past have not been used to react to macroeconomic situations, a loss of this instrument may seem acceptable. Therefore, this section provides a description of how often the generosity of depreciation for machinery and industrial buildings has changed in the past. In addition, it asks to what extent these changes of national depreciation allowances have been related to the specific macroeconomic situation. So far, the motivation behind changes of depreciation allowances has been largely neglected in the empirical literature.[3]

The review of the pattern of changes in depreciation allowances starts from the data collected by the Oxford University Centre (CBT) Tax Database.[4] The database contains information on corporate tax rates and the generosity of depreciation allowances for up to 47 countries, including 24 EU countries. We take advantage of the descriptions for industrial buildings and plants plus machinery. For these assets it contains information about the corresponding depreciation method (straight line, declining balance, declining balance with a switch to straight line or any variation thereof) and depreciation rates.[5] Although the previously mentioned information is available for some countries, data information on depreciation and corporate taxes, for at least 19 countries, starts in 1983 (allowing the calculations of annual changes for those countries beginning in 1984) and ends in 2016 with data on 47 countries.[6]

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[3] Egger and Raff (2015) look at tax base broadening in tax competition, but do not discuss changes as potentially stabilizing macro fiscal policies.

[4] Available at http://www.sbs.ox.ac.uk/faculty-research/tax/publications/data (Sept. 2017).

[5] All information applies to 1st of January of a given year, i.e., if the tax year is different than the calendar year, any reforms introduced in a given tax year that started after 1st of January will not appear in the data until the following year.

[6] Countries with tax rate and depreciation information at least since 1983 include: Australia, Austria, Belgium, Canada, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. Additional countries included at least since 2008: Argentina, Bulgaria, Brazil, Chile, China, Croatia, Czech Republic, Denmark, Estonia, Hungary, Indonesia, India, Iceland, Israel, Luxembourg, Mexico, New

The identification of improvements or deteriorations in depreciation allowances requires a precise definition of what should be considered an improvement or deterioration. In general, the investors' economic benefit from the depreciation allowance is a function of inflation, interest, and tax rates. Therefore, in the case of fundamental changes, say a switch from linear to digressive depreciation, the definition could depend on these other variables. As our aim is to focus on changes of depreciation specifically, we take a simplified, pragmatic approach. For the case of machinery, we use as a benchmark what fraction of the total investment cost can be written down in the first two years when total use is assumed to be ten years.[7] If that fraction increases, we encode this as an improvement. If it decreases, we encode the change as a deterioration. For buildings, which are often written down over a tax lifetime between 15 and 50 years, we take as a benchmark the fraction of allowances that can be used during the first five years.

Table 1 reports the picture that evolves from this exercise. Overall, for our sample, we count 50 improvements and 48 deteriorations for plant and machinery for a total of 1,235 country-years. Hence, changes in depreciation of these assets occurred in 8.1% of all years; the equivalent number for buildings is 6.2%.

Changes in depreciation allowances are less frequent than changes in the effective statutory tax rate, which in the same set of countries occurred in 27.2% of all years. The fact that tax rates change more frequently may partly derive from the fact that the effective statutory tax rates are also influenced by subnational changes, whereas depreciation allowances are typically set on the national level only.

Zealand, Poland, Romania, Russia, Saudi Arabia, Serbia, Slovak Republic, Slovenia, South Africa, South Korea, Turkey, and Ukraine.

[7] If an investor can choose between different depreciation schemes, we focus on the alternative with the fastest depreciation.

Table 1. Changes of Depreciation Allowances for Machinery and Buildings

		Machinery		Buildings			
Year	No. of Countries	Deterio-ration	Improve-ment	Deterio-ration	Improve-ment	CT reduction	CT increase
1984	19	0	0	0	0	4	3
1985	19	0	2	1	2	3	3
1986	19	3	0	2	0	4	1
1987	20	2	0	2	0	5	3
1988	20	1	2	3	0	4	0
1989	20	2	1	2	1	6	2
1990	20	1	2	2	1	6	2
1991	23	3	0	1	0	8	4
1992	29	1	3	2	2	4	4
1993	31	2	2	2	2	7	3
1994	34	1	3	1	1	11	3
1995	35	1	0	0	1	5	5
1996	38	2	1	2	1	4	5
1997	41	0	0	0	2	6	2
1998	41	2	6	3	2	10	5
1999	41	1	2	1	2	5	4
2000	41	2	0	3	0	13	4
2001	41	2	1	1	1	10	1
2002	42	4	1	2	1	13	1
2003	42	2	5	2	1	6	4
2004	42	1	1	1	1	10	1
2005	47	2	2	3	2	16	2
2006	47	2	2	2	1	12	0
2007	47	2	1	1	0	9	1
2008	47	2	1	1	0	11	1
2009	47	1	6	1	1	11	0
2010	47	0	0	1	0	8	1
2011	47	4	0	3	0	5	4
2012	47	0	0	0	0	10	4
2013	47	3	1	2	1	7	5
2014	47	0	0	0	0	6	4
2015	46	0	1	0	1	6	2
2016	45	0	1	0	0	7	1

Source: Oxford University Centre (CBT) Tax Database. We added corrections to account for Finland's investment promotion (2009-2010 and 2013-2015) based on communications with two national experts and for France's temporary measures in 2009 and 2016 based on PWC (2017). We also added selected tax rate information from Mintz and Weichenrieder (2010). Years 1981-1983 are not reported, but up to 12 country-year observations are included in regressions below.

Figure 1a. Types of Tax Reforms that Imply Changes in Depreciation (Machinery)

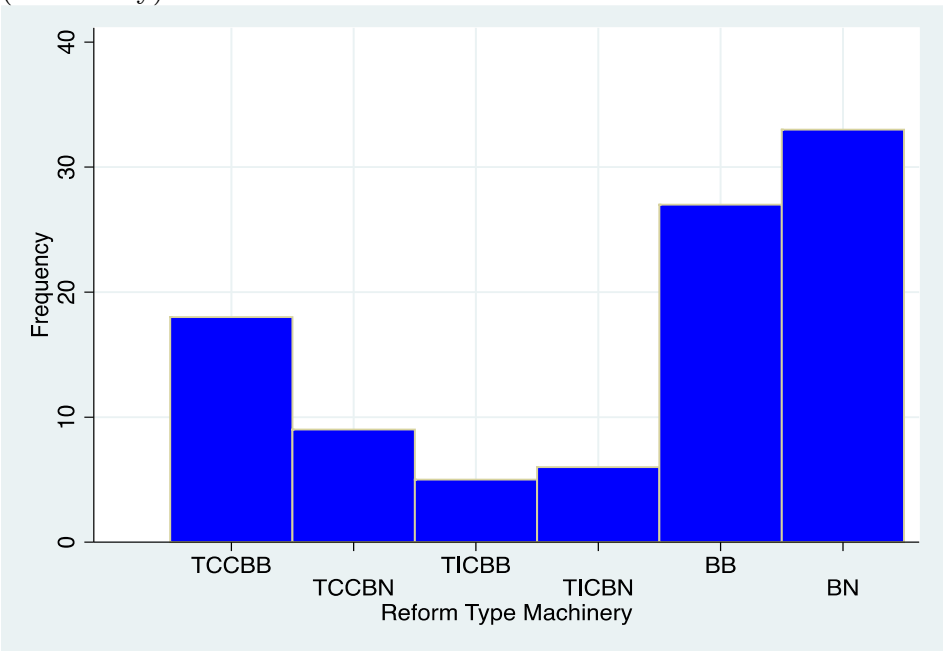
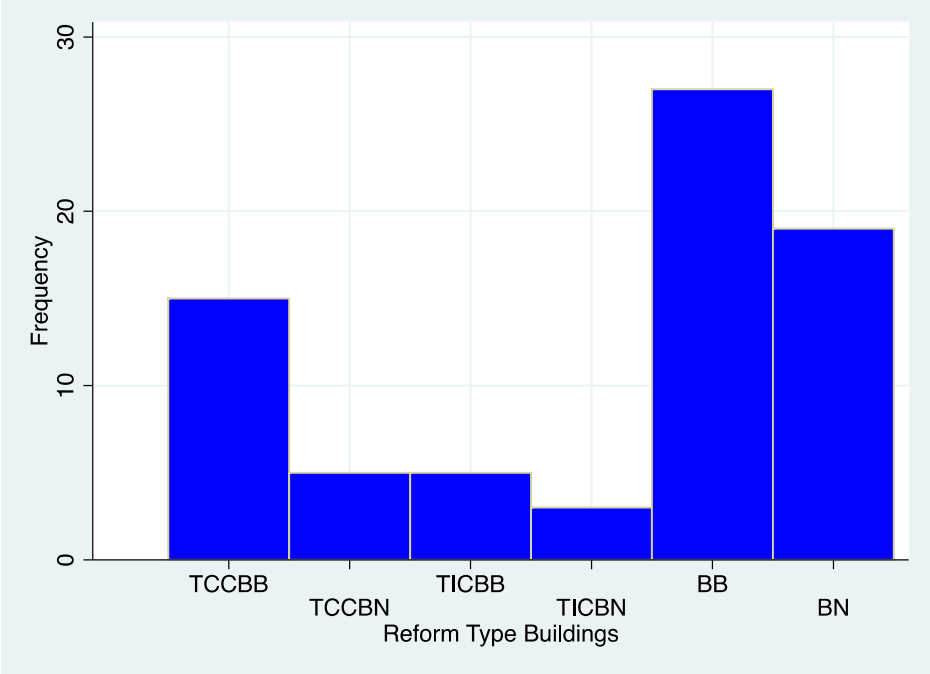


Figure 1b. Types of Tax Reforms that Imply Changes in Depreciation (Buildings)



Note: The reform types differ depending on whether a narrowing or broadening of the tax base was associated with a tax rate cut or increase in the same year. Base narrowing without change in the tax rate, BN; base broadening without tax rate changes, BB; tax cut cum base broadening, TCCBB; tax cut cum base narrowing, TCCBN; tax increase cum base broadening, TICBB; tax increases cum base narrowing, TICBN.

Figure 1a illustrates how in our sample of countries the 98 changes in depreciation allowances for machinery are connected to corporate tax rate changes.

The category with most changes (33) implies a base narrowing (more generous allowance) associated with no change in the tax rate (BN), followed by 27 cases of base broadening without tax rate changes (BB). Cases of tax cut cum base broadening (TCCBB) account for 18 changes. Less important are tax cuts cum base narrowing (TCCBN), tax increases cum base broadening (TICBB), and tax increases cum base narrowing (TICBN). Figure 1b illustrates a similar pattern for the 74 changes in depreciation allowances for buildings. Again, around 60% of all changes are not associated with tax rate changes.

How do the changes in the depreciation allowances relate to the macroeconomic conditions? One way to investigate this is to look at the narrative put forward at the time of the relevant changes in depreciation. Indeed, in many instances stimulation of the business cycle and/or investment and employment are named as the reasons behind improvements of depreciation for machinery.[8] While sometimes the business cycle is also referred to as a motive when depreciation allowances are cut back, another often cited motivations are financing needs or compensating measures to secure tax revenues.[9]

A more systematic way to gauge the role of changes in depreciation is to ask to what extent these changes are associated with unemployment and/or underutilized capacities. For this, we employ various discrete choice models in which we try to explain the probability of a change in depreciation by the general macroeconomic situation, captured by either the unemployment rate or the output gap.

Our first variable of interest is the dummy CHANGE, which indicates whether the generosity of depreciation for investment in machinery is different from the previous year. Table 2a reports results for machinery and Table 2b for buildings. In each of these tables, columns (1) to (4) report simple logit regressions of CHANGE on the unemployment rate UE, the lag of the unemployment rate, L.UE, the output gap, GAP, and the lag of the output gap, L.GAP.[10] Descriptive statistics for the regressions are reported in Appendix A. The alternative use of the lagged macro-variables is suggested by a possible policy lag whereby this year's tax change is in response to the previous year's macroeconomic situation and was accordingly legislated in the previous year. The lagged macro-variables also avoid problems of reverse causality that may result if changes in depreciation allowances have an immediate impact on the macroeconomic situation. Note that whereas a higher unemployment rate indicates a more difficult macroeconomic situation, a more positive output gap indicates a better situation. Therefore, positive signs for UE

[8] For example, the Austrian Ministry of Finance stated support of the business cycle as the reason for the 2009 change (https://www.bmf.gv.at/steuern/Beg˙Konjunkturpaket˙2009˙VorblErl.pdf?5te3iw, retrieved January 2018)

[9] See Kremer and Ruf (2008) for the German 2008 reform.

[10] The output gap is based on yearly IMF World Economic Outlook data and a HP filter ($\lambda = 100$). Unemployment rates are also taken from IMF data. While GAP and UE are, as expected, significantly negatively correlated, the size of the correlation coefficient (10%) is modest.

and L.UE and negative signs for GAP and L.GAP would support the premises that a weak economy triggers policy changes.

In addition to the macro variables, we add a time trend, YEAR.[11] To avoid that the depreciation changes in 2009, which were induced by the financial crisis, are driving our results, we add a dummy for that year, YEAR2009. Finally, we also add a dummy (POST2008) for the post-2008 period, as legislators and ministries of finance may have been kept busy with financial market regulation and may have had a lower productivity in designing tax reforms. Although these time effects are usually significant, our results do not rely on their inclusion. Columns (5) and (6) of Table 2a and 2b report conditional (fixed effects) logit regressions that use countries as groups. While this leads to dropping countries from the sample that did not experience a change in depreciation, the results are closely comparable to the simple logit results.

The results in Table 2a indicate that the probability of depreciation changes for machinery is higher if (lagged) unemployment (GAP, L.GAP) is high or the lagged output gap (L.GAP) is low. The current output gap is not significant, although the sign is the same as for L.GAP. While results are reported in coefficients, the row Marg. Eff. reports marginal effects for our main variables of interest. Taking a concrete example, the value .0058 in column (4) means that a one-point increase in the unemployment rate, on average, increases the probability of a policy change by .58 percentage points. At the same time, the average probability is close to eight percent, and the sample average of the unemployment rate is also about eight percent. The elasticity based on the delta method in column (4) is .59.

Table 2a also reports a time trend (YEAR), which is insignificant. At the same time, the YEAR2009 dummy is significantly positive, yet the POST2008 dummy is significantly negative. The first sign reflects the high policy activity at the height of the financial crisis. The second result may be seen as a confirmation that legislative bodies and finance ministries in these years were preoccupied with non-tax related issues, such as financial regulation, therefore, tax changes were scarce.

Table 2b reports the results that derive from looking at changes of the allowances for buildings. While the coefficients of UE and L.UE are significant and positive as before, the results for GAP and L.GAP as measures of the macroeconomic situation are generally insignificant. This may result from measurement problems of the output gap or with a larger attention on the unemployment rate. The dummy for 2009, except in column (5), is also insignificant. The somewhat weaker results seem to indicate that changes in the allowances for machinery are more important fiscal instruments than changes in the allowances for buildings.

[11] Including year fixed effects instead of the trend would drop a substantial number of observations because some outcomes would be completely explained by the year dummy.

Table 2a. Macroeconomic Situation and the Probability of Depreciation Changes (Machinery)

	Logit	Logit	Logit	Logit	Clogit	Clogit
UE	0.075					
	[4.03]***					
GAP		-0.005				
		[-0.63]				
L.GAP			-0.018			-0.019
			[-2.22]**			[-2.23]**
L.UE				0.081	0.135	
				[4.30]***	[5.16]***	
Marg. Eff.	*0.0053*	*-0.0004*	*-0.0013*	*0.0058*	*0.0030*	*-0.0001*
	*[3.99]****	*[-0.63]*	*[-2.20]***	*[4.22]****	*[0.04]*	*[-0.59]*
YEAR	-0.022	-0.022	-0.023	-0.025	0.002	-0.01
	[-1.39]	[-1.36]	[-1.49]	[-1.57]	[0.11]	[-0.62]
YEAR2009	1.715	1.612	1.873	1.872	2.186	2.016
	[4.76]***	[4.23]***	[4.52]***	[5.24]***	[6.09]***	[4.61]***
POST2008	-0.966	-0.849	-0.766	-0.929	-1.281	-0.906
	[-2.35]**	[-2.00]**	[-1.81]*	[-2.25]**	[-3.13]***	[-2.25]**
Obs.	1231	1231	1231	1231	971	971
Log likelihood	-325.05	-331.55	-329.14	-323.87	-241.36	-244.32
Pseudo R2	0.05	0.03	0.04	0.05	0.06	0.04

Note: Endogenous variable, CHANGE, is one if depreciation allowance for machinery at start of year is different from previous year, and zero otherwise. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constants not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

The endogenous variable CHANGE is used in Tables 2a and 2b does not differentiate between improvements and deteriorations of depreciation allowances. For this reason, the endogenous variable used in Tables 3a and 3b, OCHANGE, allows for three alternatives; 1 = deterioration, 2 = no change, 3 = improvement. The reported outcomes are for six multinomial logit models in both tables.

Interestingly, the results, in particular those using the concurrent or the lagged unemployment rate, suggest that a bad macroeconomic situation may not only increase the probability of a change towards more generosity, but it also increases the probability for a deterioration. While this result may be surprising, one should keep in mind that our sample of 47 countries are quite heterogeneous. Especially when it comes to countries with limited fiscal space, these countries may not be able or willing to give up tax revenues in difficult times. A simple measure of the

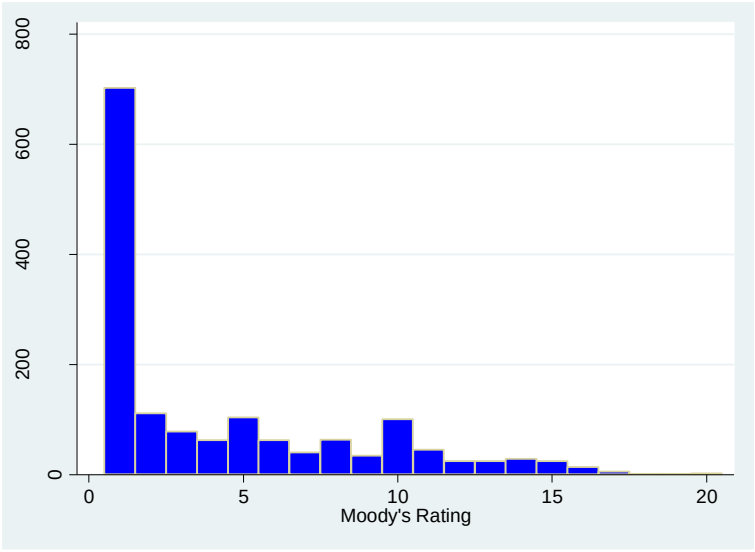
market's evaluation of fiscal space is a country's credit rating. For this reason, we also run regressions concentrating on country years during which the respective country has a rating in the prime segment of Moody's (Aaa to A3).

Table 2b. Macroeconomic Situation and the Probability of Depreciation Changes (Buildings)

	Logit	Logit	Logit	Logit	Clogit	Clogit
UE	0.084					
	[3.89]***					
GAP		-0.009				
		[-1.11]				
L.GAP			-0.014			-0.014
			[-1.45]			[1.30]
L.UE				0.084	0.194	
				[3.73]***	[3.84]***	
Marg. Eff.	*0.00461*	*-0.0005*	*-0.0008*	*0.0046*	*2.24e-11*	*-9.85e-08*
	*[3.90]****	*[-1.09]*	*[-1.41]*	*[3.75]****	*[0.45]*	*[-0.82]*
YEAR	-0.038	-0.036	-0.037	-0.040	-0.027	-0.041
	[-1.92]*	[-1.79]**	[-1.89]*	[-2.06]**	[-1.43]	[1.92]*
YEAR2009	0.519	0.405	0.616	0.668	1.087	0.681
	[1.15]	[0.85]	[1.13]	[1.49]	[2.43]**	[1.11]
POST2008	-0.707	-0.586	-0.532	-0.657	-1.042	-0.616
	[-1.15]	[-0.92]	[-0.84]	[-1.06]	[-1.81]*	[1.05]
Obs.	1228	1228	1228	1228	919	919
Log likelihood	-264.3	-264.47	-270.68	-269.99	-184.9	-191.05
Pseudo R2	0.05	0.05	0.03	0.03	0.08	0.05

Note: Endogenous variable, CHANGE, is one if depreciation allowance for buildings at start of year is different from previous year, and zero otherwise. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constants not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

Figure 2. Distribution of Country-Year Observations across Ratings



Note: Ratings as applied at start of respective country-year. 1 = Aaa, 2 = Aa1, 3 = Aa2, 4 = Aa3, 5 = A1, 6 = A2, 7 = A3, 8 = Baa1, 9 = Baa2, 10 = Baa3, 11 = Ba1, 12 = Ba2, 13 = Ba3, 14 = B1, 15 = B2, 16 = B3, 17 = Caa1, 18 = Caa2, 19 = Caa3, 20 = Ca.

Figure 2 illustrates the distribution of country-year observations across the different Moody ratings. In total, concentration on the prime segment drops 309 country-years. Indeed, this sample of well-rated countries used in columns (5) and (6) of Table 3a yields insignificant results for deteriorations, but continues to imply a significant correlation between the macroeconomy and the probability for depreciation improvements. These results suggest that sufficient fiscal space is elementary for countries to use depreciation allowances as a fiscal instrument, in order to boost the economy.

Table 3b reports the results for the depreciation of buildings. Again, using the full sample, a higher unemployment seems to foster both improvements and deteriorations of depreciations. However, the results for deteriorations turn insignificant, if the sample is restricted to the more creditworthy countries.

Investigating the changes in tax depreciation is motivated by the fact that a CCCTB may restrict fiscal policies of participating EU countries. For this reason, Appendix B, as a robustness check, presents regressions corresponding to those of Tables 2a, 2b, 3a, and 3b, but excludes non-EU countries. The results are very closely comparable to the ones presented above. Despite smaller numbers of observations, significance levels are generally preserved, sometimes even improved.

Our last step in the investigation of the connection between depreciation changes and the macroeconomy is to look at the possibility of joint reforms of depreciation and taxes. As illustrated by Figure 1, changes of depreciation allowances may or may not be connected to corporate tax rate changes. Because tax rate changes may be considered an outcome variable, we avoided using them as right-hand variables in the regressions above.

Table 3a. Improvements versus Deterioration of Depreciation (Machinery)

	Mlogit	Mlogit	Mlogit	Mlogit	Mlogit low risk	Mlogit low risk
Deterioration						
UE	0.071				0.060	
	[3.22]***				[1.28]	
GAP		0.005				
		[0.45]				
L.GAP				-0.011		
				[-0.96]		
L.UE			0.072			0.0642
			[3.32]***			[1.34]
Marg. Eff.	*0.0026*	*0.0002*	*0.0026*	*-0.0004*	*0.0020*	*0.0021*
	*[2.91]****	*[0.52]*	*[2.94]****	*[-0.84]*	*[1.12]*	*[1.17]*
Improvement						
UE	0.079				0.102	
	[3.15]***				[3.10]***	
GAP		-0.016				
		[-1.89]*				
L.GAP				-0.026		
				[-2.98]***		
L.UE			0.091			0.120
			[3.46]***			[3.74]***
Marg.	*0.0028*	*-0.0006*	*0.0032*	*-0.0009*	*0.0037*	*0.0043*
Eff.	*[3.09]****	*[-1.91]**	*[3.36]****	*[-2.83]****	*[3.60]****	*[4.44]****
Obs.	1231	1231	1231	1231	750	750
Log likelihood	-390.06	-395.59	-388.77	-393.70	-231.99	-230.42
Pseudo R2	0.05	0.03	0.05	0.04	0.05	0.06

Note: Endogenous variable, OCHANGE, is one if depreciation allowance for machinery at start of year has deteriorated from the previous year, two if the same, and three if improved. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap and L.UE, as applicable.

Table 3b. Improvements versus Deterioration of Depreciation (Buildings)

	Mlogit	Mlogit	Mlogit	Mlogit	Mlogit low risk	Mlogit low risk
Deterioration						
UE	0.082				0.067	
	[2.96]***				[1.34]	
GAP		-0.004				
		[-0.34]				
L.GAP				-0.013		
				[-0.97]		
L.UE			0.081			0.060
			[2.77]***			[1.10]
Marg. Eff.	*0.0029*	*-0.0001*	*0.0029*	*-0.0005*	*0.0024*	*0.0022*
	*[2.73]****	*[-0.29]*	*[2.54]***	*[-0.88]*	*[1.23]*	*[1.02]*
Improvement						
UE	0.099				0.144	
	[3.15]***				[2.52]**	
GAP		-0.020				
		[-1.98]**				
L.GAP				-0.018		
				[-1.36]		
L.UE			0.100			0.1368
			[3.19]***			[2.69]***
Marg. Eff.	*0.0020*	*-0.0004*	*0.0021*	*-0.0004*	*0.0025*	*0.0024*
	*[2.56]****	*[-2.11]***	*[2.57]****	*[-1.34]*	*[2.21]***	*[2.27]***
Obs.	1199	1199	1199	1199	731	731
Log likelihood	-309.84	-316.30	-309.97	-315.96	-181.38	-181.82
Pseudo R2	0.05	0.03	0.05	0.03	0.06	0.06

Note: Endogenous variable, OCHANGE, is one if depreciation allowance for buildings at start of year has deteriorated from the previous year, two if the same, and three if improved. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

One possibility is to formulate a multinominal logit model that consists of the following comprehensive choice set: O = No reform (baseline option); TI = No depreciation change, corporate tax increase; TC = No depreciation change, corporate tax cut; TCCBN = Improvement of depreciation, corporate tax cut; TICBN = Improvement of depreciation, corporate tax rate cut; BN. Improvement of depreciation, no change in the corporate tax rate; TCCBB = Deterioration of depreciation, increase in the corporate tax rate; TCCBN = Deterioration of

depreciation, decrease in the corporate tax rate; BB = Deterioration of depreciation, no change in the corporate tax rate.

Table 4a reports results for the full sample and Table 4b reports the highly rated country-years (Moody's A3, or better). In each table, we report results using either L.GAP or L.UE as variables describing the macroeconomy. The first two columns examine machinery, the last two columns focus on the depreciation of buildings.

Although some results appear, not all reforms are made more likely by a weak macroeconomic situation. We tend to see an increased likelihood for a tax cut cum base narrowing (TCCBN) and for a base narrowing without tax rate change (BN). At the same time, we find no evidence in the full sample that a high unemployment rate decreases the likelihood of a deterioration of depreciation that comes with a tax increase (TICBB). For buildings, the results even suggest that a high unemployment increases the likelihood for TICBB. Such a tax reform may be considered inadequate to improve the economy, but could be motivated by budget requirements. Such an interpretation is supported by the fact that the sign of L.UE for machinery changes from being insignificant to being significantly negative, once countries with a low rating are excluded from the sample and the sign for buildings changes. Finally, high unemployment also seems to increase the likelihood of reforms that imply a tax cut cum base broadening (TCCBB), but this result loses statistical significance in the sample of highly rated countries when we look at machinery and turns to being significantly negative for buildings.

Taken together, our empirical investigation suggests that macroeconomic factors affect the likelihood of a change in depreciation allowances. The macroeconomic situation may be proxied by different variables. In our regressions, the unemployment rate seems to be a better predictor than our measure of the output gap. Improvements of depreciation are more likely in a weak economy. While impairments of depreciations may also happen more often in below average situations, this effect tends to be driven by countries with a poor credit standing and thus these measures may be rationalized by budgetary requirements rather than efforts to stimulate the economy.[12]

[12] One may note that macroeconomic literature discusses whether in high-debt countries a consolidation of the budget can provide a positive macroeconomic stimulus. However, several papers seem to imply that such surprising expansionary effects, if at all, derive from expenditure cuts rather than from tax increases. For a recent contribution to this literature, see Alesina, Favero and Giavazzi (2015).

Table 4a. Reform Types (Multinominal Logit)

	Machinery	Machinery	Buildings	Buildings
TI = *No* depreciation change, *increase* in the corporate tax rate				
L.GAP		-0.001		-0.006
		[-1.00]		[-0.61]
L.UE	0.011		0.015	
	[0.33]		[0.49]	
TC = *No* depreciation change, *decrease* in the corporate tax rate				
L.GAP		-0.008		-0.007
		[-1.30]		[-1.11]
L.UE	-0.032		-0.029	
	[-1.33]		[-1.20]	
TCCBN = *Improvement* of the depreciation, *decrease* in the corporate tax rate				
L.GAP		-0.027		-0.048
		[-1.44]		[-2.25]**
L.UE	0.114		0.140	
	[2.43]**		[2.63]***	
TICBN = *Improvement* of the depreciation, *increase* in the corporate tax rate				
L.GAP		-0.017		-0.044
		[-0.67]		[-1.63]
L.UE	0.118		0.019	
	[3.01]***		[0.47]	
BN = *Improvement* of the depreciation, *no* change in the corporate tax rate				
L.GAP		-0.031		-0.008
		[2.84]***		[-0.50]
L.UE	0.068		0.079	
	[2.59]***		[2.54]**	
TICBB = *Deterioration* of the depreciation, *increase* in the corporate tax rate				
L.GAP		-0.009		-0.033
		[-0.22]		[-1.13]
L.UE	0.0946		0.144	
	[1.11]		[2.40]**	
TCCBB = *Deterioration* of the depreciation, *decrease* in the corporate tax rate				
L.GAP		-0.015		-0.017
		[-0.71]		[-0.97]
L.UE	0.079		0.065	
	[2.65]***		[1.71]*	

BB = *Deterioration* of the depreciation, *no* change in the corporate tax rate				
L.GAP		-0.013		-0.008
		[-0.84]		[-0.49]
L.UE	0.053		0.059	
	[1.24]		[1.11]	
Obs.	1228	1228	1226	1226
Log likelihood	-1270.80	-1276.87	-1990.28	-1997.16
Pseudo R2	0.03	0.03	0.03	0.03

Note: Endogenous variable, OUTCOME, is zero in our baseline line specification, in which there is no change either in the corporate tax rates nor in the depreciation allowances for machinery (columns 1 and 2) and buildings (columns 3 and 4). The variable can also take the value from one to eight, as presented in the table. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported.

Table 4b. Reform Types for Highly Ranked Countries (Multinominal Logit)

	Machinery	Machinery	Buildings	Buildings
TI = *No* depreciation change, *increase* in the corporate tax rate				
L.GAP		0.001		-0.002
		[0.10]		[-0.15]
L.UE	0.002		0.005	
	[0.03]		[0.12]	
TC = *No* depreciation change, *decrease* in the corporate tax rate				
L.GAP		-0.022		-0.022
		[-2.12]**		[-2.17]**
L.UE	-0.043		-0.038	
	[-1.14]		[-1.07]	
TCCBN = *Improvement* of the depreciation, *decrease* in the corporate tax rate				
L.GAP		-0.021		0.062
		[-0.51]		[-1.48]
L.UE	0.159		0.204	
	[1.67]*		[2.61]***	
TICBN = *Improvement* of the depreciation, *increase* in the corporate tax rate				
L.GAP		-0.032		-0.006
		[-2.97]***		[-0.84]
L.UE	0.207		0.024	
	[2.04]**		[0.48]	

BN = *Improvement* of the depreciation, *no* change in the corporate tax rate				
L.GAP		-0.037		-0.025
		[-2.65]***		[-0.69]
L.UE	0.095		0.113	
	[2.57]**		[2.21]**	
TICBB = *Deterioration* of the depreciation, *increase* in the corporate tax rate				
L.GAP		-0.119		-0.008
		[-9.06]***		[-0.16]
L.UE	-0.378		0.135	
	[-4.63]***		[1.44]	
TCCBB = *Deterioration* of the depreciation, *decrease* in the corporate tax rate				
L.GAP		-0.020		0.027
		[-0.56]		[1.59]
L.UE	0.063		-0.163	
	[1.45]		[-2.51]**	
BB = *Deterioration* of the depreciation, *no* change in the corporate tax rate				
L.GAP		-0.019		-0.017
		[-0.82]		[-0.64]
L.UE	0.063		0.069	
	[1.08]		[1.16]	
Obs.	750	750	750	750
Log likelihood	-749.06	-751.41	-702.50	-705.27
Pseudo R2	0.05	0.04	0.05	0.04

Note: Endogenous variable, OUTCOME, is zero in our baseline line specification, in which there is no change either in the corporate tax rates or in the depreciation allowances for machinery (columns 1 and 2) and buildings (columns 3 and 4). The variable can also take the value from one to eight, as presented in the table. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported.

3 Investment Incentives under Separate Accounting, Formula Apportionment, and a Hybrid System

The above empirical evidence suggests that changes of depreciation allowances have been used in the past as a fiscal instrument for stabilization. In this section, we argue that this instrument can survive in a hybrid CCCTB framework. The basic idea relies on the fact that profits consist of a sum of different revenue and cost categories. Instead of using a common formula for everything, different formulas for distinct components of profits are conceivable. Therefore, numerous

linear (hybrid) combinations of separate accounting and formula apportionment are possible. We leave the formal argument to Appendix C and directly concentrate on the case in which only one cost item is left out of formula apportionment and the joint tax base: the depreciation allowance.

We concentrate on the investment incentives under a hybrid system and compare this situation to two reference scenarios: one in which there is no formula apportionment (i.e., separate accounting) and one in which the CCCTB formula is applied to all types of cost (i.e., formula apportionment).

Consider a multinational operating in member states, A and B. Let the economic profit, π_A and π_B, in these two countries (before taxes) be described as

$$\pi_A = f_A(L_A, K_A) - w_A L_A - (r + \delta_A)K_A \; ; \; \pi_B = f_B(L_B, K_B) - w_B L_B - (r + \delta_B)K_B, \tag{3}$$

where δ_A, δ_B denote economic depreciation of capital in the two countries; L_A, L_B signify labor; K_A, K_B are the capital variables; w_A, w_B depict wages; and r is the interest rate, which captures the opportunity cost of investors. For simplicity, we take into account a one-period model. We capture more or less generous depreciation by assuming that tax law may possibly allow the deduction of a larger or smaller fraction α of capital from the tax base than the one suggested by economic depreciation at the relevant rates (δ_A, δ_B). Therefore, depending on the taxation regime, we derive different expressions for taxes due. If separate accounting is applied, we have

$$T_s = \tau_A(\pi_A - K_A \cdot (\alpha_A - \delta_A)) + \tau_B(\pi_B - K_B \cdot (\alpha_B - \delta_B)) \; . \tag{4}$$

Conversely, if formula apportionment is applied comprehensively to all cost categories, we have

$$T_c = [\tau_A \cdot \varphi_A(.) + \tau_B \cdot \varphi_B(.)] \cdot \left(\pi_A + \pi_B - (K_A + K_B) \cdot \alpha_c + \delta_A K_A + \delta_B K_B\right), \tag{5}$$

where $\varphi_A(.)$ and $\varphi_B(.)$ are the fractions of the tax base allocated to countries A and B. These fractions are a function of the variables entering formula apportionment, which may comprise real capital, payroll, the number of workers and sales to third parties, or a combination of subsets of these variables.

Finally, in a hybrid system, the taxes due are represented by

$$T_h = [\tau_A \cdot \varphi_A(.) + \tau_B \cdot \varphi_B(.)] \cdot \left(\pi_A + \pi_B + \delta_A K_A + \delta_B K_B\right) - \tau_A \alpha_A K_A - \tau_B \alpha_B K_B, \tag{6}$$

In the case of separate accounting, the multinational maximizes net of tax profits $\pi_A + \pi_B - T_s$ and the cost of capital for the affiliate in country $i = A, B$ is derived by the first order condition with respect to K_i.

$$(1 - \tau_i)(\partial f_i / \partial K_i - r) - \delta_i + \tau_i \alpha_i = 0, \tag{7}$$

which yields the cost of capital as

$$coc_{si} = \partial f_i / \partial K_i - \delta_i = r + (\delta_i - \alpha_i)\frac{\tau_i}{1 - \tau_i}. \tag{8}$$

The interpretation of this expression for the cost of capital is straightforward. Because the financing cost is assumed to be deductible, the cost of capital equals

the interest rate, if tax allowance for depreciation equals economic depreciation ($\delta_i = \alpha_i$), but differs from the interest rate if tax allowances are more or less generous.

Now, we turn to formula apportionment. Here, the net of tax profit is $\pi_A + \pi_B - T_c$, and the first order condition with respect to K_A is

$$\frac{\partial f_A}{\partial K_A} - r - \delta_A - [\tau_A\varphi_A + \tau_B\varphi_B]\left(\frac{\partial f_A}{\partial K_A} - r - \alpha_c\right)$$
$$-\left\{\frac{\partial \varphi_A}{\partial K_A}\tau_A + \frac{\partial \varphi_B}{\partial K_A}\tau_B\right\}(\pi_A + \pi_B - (K_A + K_B)\alpha_c + \delta_A K_A + \delta_B K_B) = 0 \quad (8)$$

After rearranging terms, we have for the cost of capital

$$coc_{cA} = \frac{\partial f_A}{\partial K_A} - \delta_A = r + \frac{\delta_A - [\tau_A\varphi_A + \tau_B\varphi_B]\alpha_c}{Z} - \delta_A$$
$$-\frac{1}{Z}\left\{\frac{\partial \varphi_A}{\partial K_A}\tau_A + \frac{\partial \varphi_B}{\partial K_A}\tau_B\right\}(\pi_A + \pi_B - (K_A + K_B)\alpha_c + \delta_A K_A + \delta_B K_B) \quad (9)$$

Here, $Z \coloneqq [1 - \tau_A\varphi_A - \tau_B\varphi_B]$. In the event that $\delta_A = \alpha_c$, the second and third terms on the RHS are canceled. If, in addition, $\frac{\partial \varphi_A}{\partial K_A}\tau_A + \frac{\partial \varphi_B}{\partial K_A}\tau_B = 0$, then the cost of capital again is equated to the interest rate. However, if the latter condition is not fulfilled, the cost of capital is not only a function of the tax rates and depreciation allowances, but also of the total pre-tax profits $\pi_A + \pi_B$. Hence, unlike under SA (cf. eq. (8)), equating tax depreciation to economic depreciation is generally not enough to avoid investment distortions.

Now, consider the cost of capital in a hybrid system in which a common tax base is applied to all cost and revenue components, but whereby depreciation can be chosen nationally. The first order condition of the multinational that maximizes net of tax profits is

$$\frac{\partial f_A}{\partial K_A} - r - \delta_A - [\tau_A\varphi_A + \tau_B\varphi_B]\left(\frac{\partial f_A}{\partial K_A} - r\right) + \tau_A\alpha_A$$
$$-\left\{\frac{\partial \varphi_A}{\partial K_A}\tau_A + \frac{\partial \varphi_B}{\partial K_A}\tau_B\right\}(\pi_A + \pi_B + \delta_A K_A + \delta_B K_B) = 0 \quad (10)$$

After rearranging the terms, we receive

$$coc_{hA} = \frac{\partial f_A}{\partial K_A} - \delta_A = r + \left(\frac{1}{Z} - 1\right)\delta_A + \frac{\left[\tau_A\frac{\partial \varphi_A}{\partial K_A} + \tau_B\frac{\partial \varphi_B}{\partial K_A}\right]}{Z}(\pi_A + \pi_B + \delta_A K_A + \delta_B K_B) - \frac{\tau_A\alpha_A}{Z} \quad (11)$$

How does a change in the generosity of tax depreciation allowances affect the cost of capital in the different regimes (*s*, *c*, *h*)? The simplest expression is in the case of separate accounting.

$$\frac{\partial coc_{sA}}{\partial \alpha_A} = -\frac{\tau_A}{1-\tau_A} \quad (12)$$

In the case of formula apportionment, (ignoring repercussions of a change of α_c on φ_A, φ_B - strictly speaking only permissible in symmetric situation) we have

$$\frac{\partial coc_{cA}}{\partial \alpha_c} = -\frac{[\tau_A\varphi_A + \tau_B\varphi_B]}{Z} + \frac{1}{Z}\left\{\frac{\partial \varphi_A}{\partial K_A}\tau_A + \frac{\partial \varphi_B}{\partial K_A}\tau_B\right\}(K_A + K_B)\alpha_c \quad (13)$$

In the case of a symmetric situation, ($\tau_A = \tau_B$; $\varphi_A = \varphi_B$), the effect on the cost of capital simplifies to $-\frac{\tau_e}{1-\tau_e}$, with $\tau_e = \tau_A\varphi_A + \tau_B\varphi_B$. This is equivalent to the expression in equation (12), but with the effective tax rate τ_e taking on the role of the national rate.

Finally, in a hybrid system, we have

$$\frac{\partial coc_{hA}}{\partial \alpha_A} = -\frac{\tau_A}{Z} \tag{14}$$

Again, this derivation ignores the indirect effect on φ_A and φ_B that a change in α_A may have via a change in the amounts of K_A and K_B. In general, a more generous depreciation allowance in country A will put more weight on country A (increase φ_A) and less on country B (reduce φ_B). If country A has the higher (lower) tax rate, this will have a countervailing increasing (reinforcing negative) effect on $\frac{\partial coc_{hA}}{\partial \alpha_c}$, which is not represented in equations (13) and (14).[13]

Unlike under formula apportionment, the denominator in equation (14) is now given by the national tax rate rather than the weighted tax rates of countries *A* and *B*. By the definition of Z, the tax rate τ_B is still affecting the change in the cost of capital in country A. A low tax rate in that other country may continue reducing the investment stimulus, but the channel is only via the denominator of (14) and should therefore be lower than in the case of formula apportionment.

As a take-home message, we have the result that a more generous depreciation allowance has a positive effect on investment incentives also under a hybrid system. This said, a hybrid system, just like formula apportionment, would introduce more complicated effects on the cost of capital. These effects derive if tax rates differ between countries and, at the same, time capital enters the formula that allocates profits to either high or low-tax countries.[14]

[13] For a discussion of weight effects from tax rate changes under traditional formula apportionment, see Mintz and Weiner (2003), Pethig and Wagner (2007), or Kari et al. (2018).

[14] A remaining remark refers to possible transfer pricing incentives in the hybrid system. As in a FA system, those are in general eiminated in a hybrid system. An exception applies if an investment good is produced in one part of the multinational, but sold to another part and installed there. In a hybrid system, the sales revenues for this transaction would be taxed at the average tax rate, while the value of the depreciation allowances are higher, the higher the tax rate of the investing part.

4 Alternatives to Accelerated Depreciation and their Feasibility

In our above discussion, we have discussed changes in depreciation allowances as a national measure to spur investment. Conceivably, if national discretion is taken away, several alternatives may fill the gap.

One possibility is to reduce the tax rate in order to encourage more investment. Although this would be a measure to attract investment from abroad, the effect on domestic investments is unclear. It cannot be ruled out that a reduction of the corporate income tax would reduce investment incentives via the "tax paradox", namely as a lower tax rate reduces the benefit of shifting taxes into the future, local real investments may lose attractiveness compared to international financial investments (see, e.g., Sinn, 1987). Indeed, in Section 2, unlike with changes in depreciation allowances, we did not find a systematic correlation of changes in statutory corporate tax rates and the macroeconomic indicators.

A further possible alternative is to allow national governments to introduce temporary investment subsidies. Indeed, from a theoretical point of view, such measures could very well act as a substitute to accelerated depreciation. Yet, practical problems should not be overlooked. One issue, in particular, applies when it comes to new firms. Similar to problems in the area of VAT fraud, pouring out money based on firms' claims of investment up front are more susceptible to tax fraud than measures based on delayed taxation because new firms may take the money in advance and secretly leave before the investments actually are made. Perhaps a more important problem is the EU Commission's state aid control. Under EU law, the Commission has a very strong position to interdict national measures having the potential to distort European trade.[15] Member states are required to notify investment subsidies in advance and may only implement them after the Commission has consented. Even if the Commission policy were lenient, prior notification and consent would be a problem for timely stabilization measures. In addition, the Commission's attitude towards national policies can hardly be considered lenient and in fact has been criticized for lacking reliability and consistency.[16] Based on the fear that this may give an undue advantage to sectors with many female employees, the Commission, for example, has intervened against reduced social security payments for Italian women. On the other hand, the EU Commission consents to patent boxes within the EU that provide preferential tax treatment to income form intellectual property on the basis that such income, in principle, could be earned by all companies. From recent experiences, therefore, the proper application of investment subsidies required a substantial change in state

[15] Indeed, the EU Commission is not required to give any evidence that such a distortion actually applies.

[16] See Wissenschaftlicher Beirat beim Bundesministerium der Finanzen (2017).

aid control and probably a change of the treaties to yield sufficient reliability and effectiveness.

5 Conclusion

This paper has discussed a specific implication of a CCCTB in Europe, namely the absence of national depreciation measure to influence the macroeconomy. Given the absence of national monetary policies in the Eurozone, many economists hold that the role of fiscal policies to react to idiosyncratic national shocks is particularly prominent. Therefore, the abolition of national depreciation measures may be particularly costly.

Against this background, the paper reviews the past experience of changes in depreciation allowances and finds a correlation between the macroeconomic situation and the probability of changes in depreciation rules. This evidence together with the various changes during the height of the recent financial crisis suggest that this policy instrument has been used in the past.

The paper argues that a hybrid system, in which national depreciation rules prevail despite formula apportionment, is plausible. The last version of the Commission proposal recommends an allowance for corporate equity, which, effectively, would act as if there is an immediate deduction of investment outlays (EU Commission, 2016). Against this point of comparison, leaving depreciation to the government could not be more generous, leaving little concern about a race to the bottom in which countries strive to obtain the maximum deduction permitted. While immediate deduction would be allowed, such a benchmark, obviously, is not considered problematic by the Commission proposal.

An alternative to preserving national discretion over depreciation would be to allow for national investment subsidies. Given the recent discussion about the reliability and consistency of EU state aid processes, such a solution would probably also require a common framework. Unlike in the case of open subsidies, accelerated depreciation has a clearly defined upper limit: immediate deduction. This may be an advantage over investment subsidies.

One open issue is that a better understanding may be required of the fiscal spillover effects between a member state that choses a national subsidy or a national special depreciation and the subsequent effects on its partner countries. Whereas the CCCTB always leaves the tax rate as an instrument for tax competition, giving additional leeway for choosing depreciation is complicating the picture. We leave this for future research.

Appendix A. Descriptive Statistics

Table 5a. Summary Statistics for Table 2a (Machinery).

	Obs.	Mean	Std. Dev.	Min.	Max.
CHANGE	1231	0.0796	0.2708	0	1
UE	1231	8.0644	4.7138	0.5	27.8
L.UE	1231	8.0483	4.6934	0.5	27.8
GAP	1231	-0.5366	13.0907	-54.2374	63.9433
L.GAP	1231	-0.1976	13.2916	-54.2374	63.9433
YEAR2009	1231	0.0382	0.1917	0	1
POST2008	1231	0.3030	0.4597	0	1
YEAR	1231	2002.333	8.9538	1981	2016

Table 5b. Summary Statistics for Table 2b (Buildings).

	Obs.	Mean	Std. Dev.	Min.	Max.
CHANGE	1228	0.0603	0.2381	0	1
UE	1228	8.0591	4.7174	0.5	27.8
L.UE	1228	8.0466	4.6985	0.5	27.8
GAP	1228	-0.5391	13.1059	-54.2374	63.9433
L.GAP	1228	-0.2018	13.3070	-54.2374	63.9433
YEAR2009	1228	0.0383	0.1919	0	1
POST2008	1228	0.3037	0.4601	0	1
YEAR	1228	2002.333	8.9079	1981	2016

Table 6a. Summary Statistics for Table 3a (Machinery).

	Obs.	Mean	Std. Dev.	Min.	Max.
OCHANGE*Mach	1231	1.9984	0.2823	0	3
UE	1231	8.0644	4.7138	0.5	27.8
L.UE	1231	8.0483	4.6936	0.5	27.8
GAP	1231	-0.5366	13.0907	-54.2374	63.9433
L.GAP	1231	-0.1976	13.2916	-54.2374	63.9433
YEAR2009	1231	0.0382	0.1917	0	1
POST2008	1231	0.3030	0.4597	0	1
YEAR	1231	2002.333	8.9538	1981	2016

Table 6b. Summary Statistics for Table 3b (Buildings).

	Obs.	Mean	Std. Dev.	Min.	Max.
OCHANGE˙Build	1199	1.9833	0.2480	0	3
UE	1199	8.0256	4.6782	0.5	27.8
L.UE	1199	8.0129	4.6565	0.5	27.8
GAP	1199	-0.4431	13.1331	-54.2374	63.9433
L.GAP	1199	-0.1337	13.2518	-54.2374	63.9433
YEAR2009	1199	0.0350	0.1839	0	1
POST2008	1199	0.3061	0.4611	0	1
YEAR	1199	2002.418	8.9934	1981	2016

Table 7a. Summary Statistics for Table 4a.

	Obs.	Mean	Std. Dev.	Min.	Max.
OUTCOME	1228	0.9007	1.7501	0	8
UE	1228	8.0693	4.7182	0.5	27.8
L.UE	1228	8.0541	4.6974	0.5	27.8
GAP	1228	-0.5414	13.1001	-54.2374	63.9433
L.GAP	1228	-0.2413	13.2546	-54.2374	63.9433
YEAR2009	1228	0.0383	0.1919	0	1
POST2008	1228	0.3037	0.4601	0	1
YEAR	1228	2002.377	8.9172	1981	2016

Table 7b. Summary Statistics for Table 4b.

	Obs.	Mean	Std. Dev.	Min.	Max.
OUTCOME˙B	750	0.8427	1.6980	0	8
UE	750	7.1084	3.8944	0.5	24.88
L.UE	750	7.1469	3.9444	0.5	24.88
GAP	750	0.2613	10.7876	-31.1914	41.3955
L.GAP	750	-0.0348	11.1671	-32.4512	41.3955
YEAR2009	750	0.044	0.2052	0	1
POST2008	750	0.308	0.4620	0	1
YEAR	750	2003.209	8.2128	1984	2016

Appendix B. Robustness Checks

This appendix reproduces Tables 2a, 2b, 3a, and 3b, but restricts the sample to the 24 available EU countries in our dataset.

Table 2aEU. Macroeconomic Situation and the Probability of Depreciation Changes (Machinery)

	Logit	Logit	Logit	Logit	Clogit	Clogit
UE	0.093					
	[4.9]***					
GAP		-0.014				
		[-0.96]				
L.GAP			-0.030			-0.027
			[-1.91]**			[-1.78]*
L.UE				0.108	0.110	
				[6.65]***	[2.93]***	
Marg. Eff.	*0.0075*	*-0.0011*	*-0.0024*	*0.0085*	*0.0004*	*-0.0006*
	*[5.62]****	*[-0.95]*	*[-1.91]***	*[7.19]****	*[0.98]*	*[-0.34]*
YEAR	-0.033	-0.042	-0.040	-0.035	-0.011	-0.020
	[-1.28]	[-1.65]*	[-1.63]*	[-1.38]	[-0.40]	[-0.74]
YEAR2009	1.911	1.707	2.285	2.195	2.393	2.403
	[5.15]***	[3.99]***	[3.80]***	[5.87]***	[4.96]***	[3.68]***
POST2008	-0.3188	0.025	0.101	-0.286	-0.307	-0.098
	[-0.52]	[0.05]	[0.55]	[-0.48]	[-0.46]	[0.17]
Observations	552	552	552	552	429	429
Log likelihood	-159.53	-163.19	-161.34	-157.96	-120.13	-120.98
Pseudo R2	0.06	0.04	0.05	0.07	0.06	0.05

Note: Endogenous variable, CHANGE, is one if depreciation allowance for machinery at start of year is different from previous year, and zero otherwise. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constants not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

Table 2bEU. Macroeconomic Situation and the Probability of Depreciation Changes (Buildings)

	Logit	Logit	Logit	Logit	Clogit	Clogit
UE	0.136					
	[4.81]***					
GAP		-0.015				
		[-0.66]				
L.GAP			-0.019			-0.020
			[-0.71]			[-0.68]
L.UE				0.133	0.222	
				[5.03]***	[3.12]***	
Marg. Eff.	*0.0078*	*-0.0009*	*-0.0011*	*0.0076*	*1..36e-10*	*-2.59e-07*
	*[8.03]****	*[-0.65]*	*[-0.70]*	*[7.18]****	*[0.46]*	*[-0.53]*
YEAR	-0.049	-0.063	-0.064	-0.056	-0.039	-0.068
	[-1.42]	[-1.95]**	[-1.96]*	[-1.66]*	[-1.23]	[-2.03]**
YEAR2009	0.955	0.579	0.904	1.233	1.509	0.894
	[2.78]	[1.15]	[1.02]	[3.84]***	[3.89]***	[0.95]
POST2008	-0.106	0.459	0.528	0.074	-0.031	0.690
	[-0.11]	[0.53]	[0.62]	[0.08]	[-0.03]	[0.73]
Observations	552	552	552	552	376	376
Log likelihood	-121.25	-128.38	-128.07	-121.49	-82.93	-88.28
Pseudo R2	0.09	0.04	0.04	0.09	0.10	0.05

Note: Endogenous variable, CHANGE, is one if depreciation allowance for buildings at start of year is different from previous year, and zero otherwise. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constants not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

Table 3aEU. Improvements versus Deterioration of Depreciation (Machinery)

	Mlogit	Mlogit	Mlogit	Mlogit	Mlogit low risk	Mlogit low risk
Deterioration						
UE	0.087				0.045	
	[2.91]***				[0.78]	
GAP		-0.013				
		[-0.74]				
L.GAP				-0.043		
				[-1.77]*		
L.UE			0.093			0.065
			[3.14]***			[1.17]
Marg. Eff.	*0.0039*	*0.0006*	*0.0041*	*-0.0020*	*0.0020*	*0.0028*
	*[2.62]****	*[-0.73]*	*[2.60]****	*[-1.74]**	*[0.67]*	*[0.98]*
Improvement						
UE	0.102				0.085	
	[2.75]***				[1.84]**	
GAP		-0.0135				
		[-0.93]				
L.GAP				-0.014		
				[-1.41]		
L.UE			0.128			0.128
			[3.95]***			[2.99]***
Marg. Eff.	*0.0036*	*-0.0005*	*0.0045*	*-0.0004*	*0.0030*	*0.0046*
	*[2.49]***	*[-0.89]*	*[3.59]****	*[1.26]*	*[1.75]**	*[2.83]****
Obs.	552	552	552	552	415	415
Log likelihood	-191.74	-195.47	-190.00	-193.06	-143.07	-141.37
Pseudo R2	0.07	0.05	0.07	0.06	0.07	0.08

Note: Endogenous variable, OCHANGE, is one if depreciation allowance for machinery at start of year has deteriorated from the previous year, two if the same and three if improved. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

Table 3bEU. Improvements versus Deterioration of Depreciation (Buildings)

	Mlogit	Mlogit	Mlogit	Mlogit	Mlogit low risk	Mlogit low risk
Deterioration						
UE	0.135				0.102	
	[3.52]***				[1.97]**	
GAP		-0.002				
		[-0.10]				
L.GAP				-0.022		
				[-0.67]		
L.UE			0.132			0.102
			[3.68]***			[1.94]*
Marg. Eff.	*0.0055*	*-0.0001*	*0.0054*	*-0.0009*	*0.0041*	*0.0041*
	*[3.86]****	*[-0.05]*	*[3.47]****	*[-0.63]*	*[1.70]**	*[1.67]**
Improvement						
UE	0.156				0.1879	
	[2.75]***				[2.65]**	
GAP		-0.043				
		[-1.33]				
L.GAP				-0.0123		
				[-0.33]		
L.UE			0.152			0.181
			[3.11]***			[3.12]***
Marg. Eff.	*0.0028*	*-0.0008*	*0.0027*	*-0.0002*	*0.0029*	*0.0028*
	*[2.24]**	*[-1.50]*	*[2.43]**	*[0.760]*	*[2.36]**	*[2.43]**
Obs.	537	537	537	537	403	403
Log likelihood	-141.50	-148.29	-141.73	-148.68	-101.96	-102.28
Pseudo R2	0.08	0.04	0.08	0.04	0.09	0.08

Note: Endogenous variable, OCHANGE, is one if depreciation allowance for buildings at start of year has deteriorated from the previous year, two if the same and three if improved. Robust z values in parenthesis. *,** and *** denote significance at the 10, 5 and 1 percent levels. Constant and coefficients for YEAR, YEAR2009, and POST2008 are not reported. Marg. Eff. reports the average marginal effect of UE, GAP, L.Gap, and L.UE, as applicable.

Appendix C. A Basic Framework for Thinking about a Hybrid System

The total cost of an affiliate *a* located in country A may be decomposed into $\gamma = 1 \dots G$ different components; each of these components may be subject to different definitions. One possible definition could be the one used by country A. Alternatively, there could be a uniform EU definition for the various cost components. Hence, the effective size of a cost component γ for subsidiary *a* may either be $C^{\gamma}_{a,A}$ or $C^{\gamma}_{a,EU}$. A vector of G indicator variables v^{γ} may be used to denote whether the cost category is left in the national domain ($v^{\gamma} = 0$) or in the harmonized FA domain ($v^{\gamma} = 1$). A similar decomposition can be done for revenue types $\rho = 1 \dots Q$. Revenues may either follow a national definition ($R^{\rho}_{a,A}$) or a common European Union definition ($R^{\rho}_{a,EU}$). Again, a vector of Q indicators variables i^{ρ} may denote whether the revenue category is left in the national domain or in the harmonized FA domain. Hence, in a simple example of a multinational operating in two EU countries, A and B, the tax base P_A allocated to country A is then denoted by

$$P_A = \sum_{\rho=1}^{Q}(1 - i^{\rho})R^{\rho}_{a,A} - \sum_{\gamma=1}^{G}(1 - v^{\gamma})C^{\gamma}_{a,A} \qquad (1)$$
$$+\varphi_A \left(\sum_{\rho=1}^{Q} i^{\rho} R^{\rho}_{a,EU} + \sum_{\rho=1}^{Q} i^{\rho} R^{\rho}_{b,EU} - \sum_{\gamma=1}^{G} v^{\gamma} C^{\gamma}_{a,EU} - \sum_{\gamma=1}^{G} v^{\gamma} C^{\gamma}_{b,EU} \right),$$

where φ_A is the apportionment factor that will depend on the fraction of real economic activity occurring in affiliate *a* relative to the complete company group. Besides the exact formula for this factor, the political process needs to decide about the various indicator functions. A situation in which all i's and v's are zero reflects SA, while FA is characterized by all i's and v's equaling one. Conversely, having heterogeneous values for the indicator variables implies a hybrid system that allows for national discretion over defining particular cost or revenue categories.

Besides the decision on the r's and c's, there is the decision about the factors that determine φ_A and φ_B. In principle, there could be differing φ's depending on which cost or revenue category is split up. Allocating interest expenses may make it more natural to use the distribution of capital across countries, whereas the allocation of management remunerations may suggest a stronger role for overall payroll as an apportionment factor. However, for simplicity, equation (1) introduces a common set of apportionment factors for all revenue and cost types.

Note that a common set of apportionment factors is also reflected in the FA proposal by the EU. Yet, starting from the fact that company profits are derived from the difference between various revenue and cost items may facilitate thinking

out of the box. A generalized characterization of apportionment of global profits may be written as

$$P_A' = \sum_{\rho=1}^{Q}(1-i^{\rho})R_{a,A}^{\rho} - \sum_{\gamma=1}^{G}(1-v^{\gamma})C_{a,A}^{\gamma} \qquad (2)$$
$$+\sum_{\rho=1}^{Q}\varphi_A^{\rho}i^{\rho}R_{a,EU}^{\rho} + \sum_{\rho=1}^{Q}\varphi_A^{\rho}i^{\rho}R_{b,EU}^{\rho} \quad -\sum_{\gamma=1}^{G}\varphi_A^{\gamma}v^{\gamma}C_{a,EU}^{\gamma} - \sum_{\gamma=1}^{G}\varphi_A^{\gamma}v^{\gamma}C_{b,EU}^{\gamma} ,$$

where the indexation of φ_A^{ρ} and φ_A^{γ} signals that the formula to apportion different cost and revenue categories may differ.

Why could it be an advantage to let the apportionment factors vary for different cost and revenue categories? From Hines (2010), we know that incentives for inefficient mergers and investments are more likely to occur if the factors do not appropriately explain profits across different affiliates that are subject to formula apportionment. For instance, imagine a profitable Swedish company whose income is taxed in Sweden at a very high rate. Providing that the European companies are required to allocate their profits among affiliates relying to a large extent on the location of employment, the profitable Swedish company will then have an incentive to acquire another company in a low-tax country with a large labor force (in spite of being unprofitable). In this case, the Swedish profit might be attributed to the low-tax country where it will be subject to less taxes. The above-mentioned example illustrates how the formula apportionment could create incentives for changing the ownership structure of companies and their operations, in order to decrease their tax burden. Therefore, allowing the weights to differ across various cost and revenue categories can lead to a better fit of the factors in explaining profits.

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