OECD Taxation Working Papers No. 35

Loss carryover provisions:
Measuring effects on tax
symmetry and automatic
stabilisation

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<https://dx.doi.org/10.1787/bfbcd0db-en>

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ABSTRACT

Loss Carryover Provisions: Measuring Effects on tax Symmetry and Automatic Stabilisation

Loss carryover provisions are an essential part of corporate tax systems. Economic theory suggests that perfect intertemporal loss offsets are a necessary condition for the neutrality of corporate taxation across investment projects with different risk profiles. However, in practice the tax treatment of losses does often not reach this standard, e.g., due to lack of inflation indexation or tax offset restrictions. Using detailed country-level information, this paper presents two tax policy indices capturing the effects of carryover provisions on tax symmetry and stabilisation across a total of 34 OECD and non-OECD countries. The tax symmetry index captures the effectiveness of carryover provisions, including carry-forwards and carry-backs, relative to full symmetry, while the stabilisation index captures the proportion of an adverse revenue shock on loss-making firms which is absorbed by the corporate tax system. The results show that only 18 countries provide unlimited carry-forwards and most countries do not index tax losses to inflation; only 9 countries provide carry-backs while 8 countries limit the amount of tax losses which can be offset in any given year. Cross-country comparison of the two indices suggests that these restrictions have significant impacts on tax symmetry and stabilisation. Perfect tax symmetry is not achieved by the majority of the included corporate tax systems thus implying possible tax-induced distortions towards less risky projects.

RÉSUMÉ

Les dispositions relatives au report de pertes constituent un aspect essentiel des systèmes de l'impôt sur les sociétés. Selon la théorie économique, la compensation intégrale des pertes inter-temporelles est une condition nécessaire à la neutralité du régime de l'imposition des sociétés à l'égard de projets d'investissement ayant des profils de risque différents. Toutefois, dans la pratique, le traitement fiscal des pertes ne répond pas toujours à cette exigence, en raison par exemple de l'absence d'indexation sur l'inflation ou de restrictions à la compensation des pertes. À partir de données nationales détaillées, ce document présente deux indices fiscaux qui rendent compte de l'effet des dispositions relatives au report de pertes sur la symétrie fiscale et sur la stabilisation dans 34 pays membres et non membres de l'OCDE. L'indice de symétrie fiscale mesure l'efficacité des dispositions sur le report de pertes, y compris sur les exercices postérieurs et antérieurs, par rapport à une situation de symétrie parfaite, tandis que l'indice de stabilisation rend compte de la fraction d'un choc négatif sur les recettes affectant des entreprises déficitaires qui est absorbée par le système de l'impôt sur les sociétés. Les résultats montrent que 18 pays seulement autorisent les reports sur les exercices postérieurs sans limite dans le temps et que la majorité des pays n'indexent pas les pertes fiscales sur l'inflation ; 9 pays seulement autorisent le report sur des exercices antérieurs, tandis que 8 pays limitent le montant des pertes fiscales qui peuvent être compensées au cours d'un exercice donné. Les comparaisons internationales des deux indices laissent penser que ces restrictions ont un impact significatif sur la symétrie fiscale et sur la stabilisation. La majorité des régimes d'imposition des sociétés étudiés n'offrent pas une symétrie fiscale parfaite, ce qui peut induire des distorsions fiscales en faveur des projets les moins risqués.

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SUMMARY

This paper presents two tax policy indices capturing the effects of various carryover provisions on tax symmetry and stabilisation across a total of 34 OECD and non-OECD countries.

The tax symmetry index captures the effectiveness of carryover provisions, including carry-forwards and carry-backs, relative to full symmetry, while the stabilisation index captures the proportion of an adverse revenue shock on loss-making firms which is absorbed by the corporate tax system.

The indices incorporate country-level information on corporate tax carry-forwards and carry-backs including restrictions regarding the timing as well as the amount of tax losses which can be offset in a given fiscal period; it has been collected through a WP2 questionnaire in 2016. While group-level consolidation is not addressed, the focus of this study is intertemporal loss offsetting. The main results are as follows:

- Ideally, unlimited carry-backs and carry-forwards should be provided and tax losses should be indexed to inflation to maintain their real value over time. In this case corporate taxation would be symmetric, removing tax-induced distortions towards less risky projects and increasing stabilisation effects of corporate taxation.
- However, in our sample only 18 provide unlimited carry-forwards and most countries do not index tax losses to inflation; perfect tax symmetry is therefore not achieved by the majority of the included corporate tax systems.
- 16 countries limit carry-forward periods to a certain amount of years; 8 countries limit the amount of tax losses which can be offset in any given year. Depending on the duration and intensity of the loss period these limitations can have different effects on the two tax indices.
- Given that most countries do not index tax losses carried forward to inflation, carry-backs are an effective policy, which helps to increase tax symmetry and stabilisation. In the sample only 9 countries provide carry-backs.

There can be important interactions between carryover provisions and accelerated depreciation. Since depreciation allowances are typically carried forward as part of tax losses, more acceleration implies an increase in the adverse effects of a given restriction.

LOSS CARRYOVER PROVISIONS: MEASURING EFFECTS ON TAX SYMMETRY AND AUTOMATIC STABILISATION

1. Introduction

Loss carryover provisions are an essential part of corporate tax systems. While there is a general understanding of the need to support businesses in temporary loss positions, comparative research on the effectiveness of various provisions has so far been very limited. Theory suggests that perfect intertemporal loss offsets are a necessary condition for the neutrality of corporate taxation across investment projects with different risk profiles. However, due to a range of restrictions, the tax treatment of losses does not reach this standard in any of the countries analysed in this paper. Loss carry-forwards are usually not indexed to inflation, implying that their real value declines as they are carried forward. Several countries also impose additional restrictions with regard to the size and timing of tax offsets. In this context, we develop a framework for cross-country comparisons of the effectiveness of different loss carryover provisions, and use it to analyse corporate tax systems of 34 OECD and non-OECD countries with data as of 1 July 2015.¹

For the analysis of loss carryover provisions, we first develop a conceptual framework based on the well-established theoretical literature. Second, we define two indices of effectiveness capturing the two main channels through which loss carryover provisions affect investment: the first channel is related to the automatic stabilisation effects of corporate taxation, as discussed in a broader context by Auerbach and Feenberg (2000); and the second channel focuses on the effects of carryover provisions on expected returns from risky investments, discussed among others by Auerbach (1986). Using detailed country-level information on the tax treatment of losses in 34 OECD and non-OECD countries, we compute comparable simulated tax indices corresponding to each of the two channels: a stabilisation index and a tax symmetry index.

The rest of the paper is structured as follows. Section 2 reviews some of the literature and discusses the effects of loss carryover provisions on investment. Section 3 presents a simple framework allowing for comparative analyses of the two tax indices: the stabilisation index and the tax symmetry index. Section 4 briefly describes the calculations as well as the simulation approach used to account for variation in the intensity of revenue shocks. Section 5 presents the main results, including simulated stabilisation and symmetry indices for all 34 countries. Section 6 presents a number of policy conclusions.

2. Effects of Carryover Provisions on Investment

The automatic stabilisation effects of corporate taxation have been analysed in two empirical papers, Devereux and Fuest (2009) and Buettner and Fuest (2010). Both start from the observation that the stabilising effects of corporate taxation are determined, to a large degree, by the corporate statutory tax rate. For example, in a proportional system with a 30% corporate income tax (CIT) statutory rate, a reduction of EUR 100 in gross income implies that tax liabilities fall by EUR 30 and cash flow is reduced by only EUR 70. For firms that are profitable during upturns and downturns, proportional taxes therefore

1. The cross-country comparison has been conducted using information collected through a questionnaire sent to OECD member countries. Responses to the questionnaire were received from Australia, Austria, Belgium, Canada, Chile, Costa Rica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, Netherlands, Norway, Poland, Portugal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, UK and US; although Estonia has replied to the questionnaire it could not be included in the calculations because companies are not subject to tax on their income.

have a symmetric, or a-cyclical, stabilisation effect on cash flows, always absorbing 30% of the initial (negative or positive) shock.²

However, stabilisation effects on aggregate demand depend on the degree to which changes in cash flows translate into changes in investment. If the shock is temporary and capital expenditure is driven by permanent income, shocks to cash flows will not affect investment. Smoothing capital expenditure over time may require firms to borrow the necessary funds to make up for a temporary reduction in cash flows. In perfect capital markets, internal and external financing are perfect substitutes and investment decisions will be unaffected as long as firms have access to credit. Credit-constrained firms, on the other hand, depend on internal funds to finance their investments and will therefore have to change their investment decisions as a response to a temporary shock to cash flows. Stabilisation effects of corporate taxes on investment and aggregate demand are thus in theory expected to operate only through their impact on the investment decisions of credit-constrained firms.

Consider now the case of a loss-making firm in a situation without loss carryforward or other means of intertemporal loss offsetting. That is to say, a revenue shock of EUR 100 moves the firm into a loss position. If the firm does not have any other source of positive income, the reduction in gross income translates directly into an equivalent reduction of EUR 100 in cash flow, implying that the corporate tax system does not cushion any of the impact of the initial, negative shock. Although the fraction of the shock absorbed by the tax system generally depends on each firms' profitability, the aggregate effect, in the case without carryover provisions, will be between zero and the statutory CIT rate (e.g., 30% in the example above). Corporate tax systems without carryover provisions thus provide only asymmetric stabilisation effects, in the sense that they are less effective in cushioning negative shocks than positive ones, even if they are otherwise proportional. Without carryover provisions corporate taxation would therefore have pro-cyclical effects on cash flow since the degree of absorption decreases in recessions when many businesses are likely to run losses while being constant in expansions. Allowing for perfect loss carry-forward including indexation removes this asymmetry and the corresponding pro-cyclicity, thus increasing the stabilising effect on the firms' cash flow. Again, in theory this effect will only affect aggregate demand if loss-making firms are also credit-constrained.

Taken together, the stabilising effect of corporate taxation on cash flow thus depends on the corporate tax rate as well as on the tax treatment of losses. However, to assess investment effects through cash flow stabilisation, an empirical analysis would need to account for the share of credit-constrained firms because changes in cash flow will not affect investment decisions by unconstrained firms. Therefore, empirical studies of the aggregate stabilising effect of corporate taxation typically distinguish three different groups of firms: unconstrained firms, credit-constrained and profitable firms as well as credit-constrained and loss-making firms.

Devereux and Fuest (2009) were the first to provide an empirical estimate of the stabilising effect of corporate taxation on investment of firms in the United Kingdom based on firm-level data from 1980 to 2007. Their approach is built upon a set of fairly strong assumptions. First, they assume that stabilisation of cash flow works only through the effects on credit-constrained and profitable firms, ignoring the possibility of intertemporal loss offsets. Second, the fact that information on credit constraints is not available in their main dataset (i.e., accounting information on UK-listed firms from Datastream) means that a second source, the quarterly survey of the Confederation of British Industry (CBI), has to be drawn upon to identify the share of credit-constrained firms. This approach implies that further assumptions have to be

2. In contrast, progressive tax systems have counter-cyclical effects. As marginal tax rates increase with income the per cent of the shock that is absorbed by the tax system increases in expansions and decreases in recessions. Progressive taxation is therefore expected to provide stronger stabilising effects than proportional taxation.

made: (i) if the proportion of credit-constrained firms from the CBI survey exceeds the proportion of non-taxable firms from Datastream, then all non-taxable firms are credit-constrained, and (ii) if the proportion of credit-constrained firms is lower than the proportion of non-taxable firms, then all credit-constrained firms are non-taxable. Although these assumptions allow the authors to pin down a yearly measure of stabilisation, showing only limited effects throughout the entire period, it remains unclear how sensitive these results are with regard to the assumptions.

Buettner and Fuest (2010) were able to overcome some of these data limitations by using a firm-level dataset of German manufacturers combining financial statements with firm-level information on credit constraints from the Economics and Business Data Centre in Munich. As before, the authors assume that there are no intertemporal loss offsets, implying that the aggregate stabilising effect on investment is equal to the statutory rate times the share of credit-constrained, taxable firms. Tracing this measure from the downturn in 2003 to the upturn in 2007, they find that the stabilising effect of corporate taxation varies systematically over the cycle due to two countervailing effects. On the one hand, there are more credit-constrained firms in economic downturns; on the other hand, there are also more loss-making firms (which cannot, by assumption, carry tax losses forward or backward). On the whole, the first effect dominates, implying that automatic stabilisation has been stronger in downturns, approximately 13% in 2003, and weaker in upswings, around 3% in 2007. Since it has been assumed that, for credit-constrained firms, effects on cash flows translate directly into investment spending, this result implies that, compared to a given shock on gross income, aggregate investment will be 3% to 13% higher due to the stabilising role of the corporate tax system. However, acknowledging the fact that intertemporal loss offsets may have an impact, the authors also compute a measure of aggregate investment stabilisation under perfect loss offsetting based on the assumption that revenue shocks to non-taxable, credit-constrained firms are perfectly cushioned (i.e., by a share equal to the statutory rate). This calculation shows that the potential stabilisation effect of perfect loss offsets is especially high in downturns, reaching as much as 20% (compared to the German statutory rate of 38%).

Apart from their effects on the stabilising properties of the corporate tax system, loss carryover provisions also affect investment decisions directly, through their impact on expected returns from risky investments. Consider two risky investments with the same expected pre-tax return but subject to different variances. Under a proportional tax system without intertemporal loss offsets, the riskier project (i.e., the one with the higher variance) will deliver lower expected returns since profits are taxed but losses receive no tax relief. Assuming risk-neutral investors, investment decisions will be distorted towards less risky projects. However, introducing perfect loss offsets implies that a corresponding deduction is granted for both types of projects, ensuring that the expected values are again the same. This implies that the distortion towards less risky projects is removed from the corporate tax system when perfect loss offsets are available.

The effects of tax asymmetries on investment have been investigated, for instance, by Auerbach (1986). He distinguishes between two stylised tax systems, an income and a cash flow tax system, and presents various results based on a theoretical and simulation based analysis. While imperfect loss offsets generally discourage investment, this effect disappears as accumulated tax losses increase and the firm becomes essentially tax exempt. However, with cash flow taxation adverse effects on investment persist only as long as current profits are not sufficient to cover current investments; when profits are high enough, firms may actually have an incentive to invest more than with perfect loss offsets because current costs remain deductible while future profits are not necessarily taxable. Firms with low fixed costs are more likely to be in such a position, but since actual tax systems mix elements of both stylised systems, e.g., interest deductibility and accelerated depreciation, the implications for empirical research are less clear cut. Bond and Devereux (1995) developed a theoretical analysis describing the properties of a tax on corporate income which is neutral, or non-distortive, with regard to investment decisions under uncertainty

and bankruptcy risk. Their analysis shows that this tax must, among other characteristics, treat gains and losses symmetrically.

Froot et al. (1993) argue that hedging can increase the value of a firm to the extent that it reduces the effects of adverse revenue shocks on cash flow and investment. They develop a formal model of firm-level investment and financing decisions, allowing them to characterise optimal hedging strategies. Their analysis shows that tax asymmetries, along with other potential factors such as, for instance, costly external finance, provide a rationale for firms to adapt hedging strategies aimed at mitigating the effects of adverse revenue shocks, particularly in situations where loss offsets are imperfect.

Other publications have focused on empirical analyses, for instance, combining theoretical models with tax return data to compute marginal effective tax rates for taxable and non-taxable firms. For instance, Auerbach and Poterba (1987) calculate forward-looking marginal effective tax rates for taxable and non-taxable firms, calibrating their simulations to match firm-level data from Compustat; they show that tax losses prevent firms from receiving the full incentive to invest intended by, for example, increases in accelerated depreciation or investment tax credits. In the presence of investment incentives, the forward looking effective tax rate declines substantially for taxable firms and for firms under symmetric taxation. Nonetheless the tax rate declines by much less for non-taxable firms which will receive less than half of the full statutory benefit.

Altshuler and Auerbach (1990) use US tax return data to analyse the increase in accumulated tax losses during the early 1980s, finding that it is not attributable to the introduction of other tax benefits during that period. Following up on these contributions, Devereux, Keen and Schiantarelli (1994) develop a model of optimal investment behaviour and estimate several empirical specifications based on a panel of UK firms covering 1973 to 1986. Surprisingly, their econometric results show that explicit modelling of tax asymmetries does not significantly improve the performance of their empirical investment models, neither in the Q nor the cost of capital formulation. While this result remains a puzzle, the authors speculate that it may be driven by omitted variables and measurement error, or the practice of leasing and renting of assets across firms. Cooper and Knittel (2010) use tax return data from the years 1993 to 2004 to examine the implications of an asymmetric treatment of gains and losses for US firms. Overall, they find modest effective tax rate differentials between taxable and non-taxable firms; however, use of debt finance or investment tax credits leads to substantially higher differentials, implying that the adverse effects of imperfect loss offsets are concentrated among specific sectors and firms.

Edgerton (2010) empirically investigates how firms' responsiveness to tax incentives for investment varies with taxable status and cash flow. Using a panel of financial statement data of US firms in Compustat, he estimates several investment models based on the Q-theory in order to pin down the effects of a change in taxable status on firms' responsiveness to investment incentives (i.e., bonus depreciation). Regression results imply that tax asymmetries in the US system have made bonus depreciation 4% less effective than they would have been under perfect loss offsets. Relatedly, his results also suggest that bonus depreciation would be 24% more effective if cash flows were at their historical average. Dressler and Overesch (2013) use microdata of German firms to investigate multinational investment. Their empirical analysis shows that short carryforward periods reduce investment, particularly for firms with high loss-making probabilities. In addition, they find that the estimated tax rate elasticities of investment are considerably lower for firms with larger accumulated tax losses.

Dobridge (2016) uses a regression discontinuity design to evaluate two discretionary fiscal policy measures which gave firms additional tax refunds at the end of the past two US recessions in 2001 and 2009. Tax refunds were allocated based on positive taxable income in previous years and losses in the year of the policy. For example, firms which were in a loss position in 2001 received tax refunds for their payments in the years 1996 to 2000 up to the point where they were equal to the current loss. This policy

design thus created a discontinuity with regard to the allocation of the tax refund, at the current loss level, allowing for a comparison of outcome variables between firms above and below this threshold. Based on this empirical strategy she is able to estimate causal effects of the tax refunds on the use of cash flow and financial health of firms at the time of the two recessions. Results show that while firms used around 40% of every tax refund dollar on investment in 2002, 96% of each refunded dollar was used to increase cash holdings in 2009. Further analysis suggests that worldwide macroeconomic conditions were very different at the end of the two recessions. Overall, the earlier recession was much milder, growth prospects were higher and uncertainty lower, a fact that is likely to have driven the difference in firms' behaviours between the two periods.

Although these theoretical and empirical contributions provide a rationale for perfect loss offsets, most corporate tax systems do not reach this objective due to a number of factors. First, loss carryforwards are typically not indexed to inflation, implying that a part of the real value of tax losses is lost when they are carried forward and offset against future taxable income. Second, this effect is reinforced by provisions limiting the amount of losses that can be offset in a given period as it becomes more difficult for firms to offset accumulated losses. Third, restrictions on the number of years for which losses can be carried forward can increase the amount of tax losses which expire unused. Fourth, some countries have additional restrictions regarding tax losses acquired through mergers and acquisitions. Cooper and Knittel (2010) provide an empirical estimate of the magnitude of these effects. Using an unbalanced panel of tax returns they estimate that only around one half of the real value of tax losses could be recouped by US firms during the period 1993 to 2004.

Against this background, this paper aims to provide new empirical evidence on the potential effects of actual carryover provisions, thereby providing a comparative analysis of existing rules and illuminating some of the underlying trade-offs faced by policy makers. Building on extensive data of 34 OECD and non-OECD countries, its focus lies on understanding the effects that specific carryover provisions have on a firm's ability to recoup its tax losses. However, in contrast to some of the empirical papers cited here, our analysis is not based on firm-level data and some potentially relevant policy issues therefore remain outside the scope of this paper.

First, as will be discussed in more detail below, our simulation approach uses prospective or hypothetical investment projects as a benchmark; we do not model the accumulation of tax losses at the firm level. As a consequence, our approach is not well suited to analyse firm-level decisions regarding the utilisation of tax losses and some of the empirically observed factors contributing to unused expiration cannot be captured. Our tax indices should therefore be understood as an upper bound corresponding to the case where firms make optimal use of their tax losses (given the decision space allowed by the model). Of course, the results are also conditional on a range of other assumptions, e.g. about inflation and profitability, and they are therefore not an exact measure of the stabilisation or symmetry levels faced by firms in a particular country at a particular time.

Second, we do not address the effects of group consolidation regimes on an individual entities' capability to offset losses. There are different regimes allowing entities within a corporate group to net profits and losses among group members, potentially subject to additional restrictions. Donnelly and Young (2002) distinguish four types of regimes: (i) fiscal unity; (ii) group contribution; (iii) group relief and (iv) no intra-group transfers of tax losses. The first regime treats the group as a unity for tax purposes, allowing individual entities to consolidate tax losses occurring within a given fiscal year. The second regime allows taxable income to be shifted through tax-deductible payments from profitable to loss-making entities within the same group. The third regime does not require actual payments between different entities but allows loss-making entities to transfer some of their losses to profitable entities in the same group. Under each of these regimes group membership is typically determined based on ownership thresholds and subject to a minimum period of ownership. In countries allowing for group-level

consolidation, through either of the regimes (i) to (iii), offsetting losses within the group will be preferred compared to intertemporal offsets due to the time value of money. Individual entities which are part of a group will therefore face lower probabilities of unused loss carryovers if a group consolidation regime is in place. While group consolidation rules therefore have an impact on the level of observed tax losses accumulated at the firm level, these effects will not be captured by our approach which focuses solely on loss offsetting along the time dimension as seen from the perspective of a single entity.

Third, while the discussion so far suggests that partial loss offsets can potentially have an adverse effect on firm-level cash flow and investment, the tax authorities may benefit from a certain degree of tax asymmetry. In particular, partial (or imperfect) loss offsets could help in curtailing tax fraud and abuse; due to the time value of money firms face no, or only minimal, incentives to overstate tax losses under imperfect loss offsets. In addition, partial offsetting limits also reduce government's tax revenue volatility and increase overall tax receipts as a significant share of total tax losses expires unused. These effects of tax asymmetry cannot be captured within our approach and are outside the scope of this paper.

3. Measuring Stabilisation and Symmetry across Corporate Tax Systems

In order to compare the effectiveness of carry-back and carry-forward provisions across countries, we construct two summary indices. The first is an index of the stabilising effect of a specific corporate tax system. Such measure will depend on the CIT rate, the tax treatment of losses as well as accelerated depreciation and other tax incentives. The second index captures the degree of tax symmetry achieved by each system. It is independent of the level of stabilisation and therefore of the statutory CIT rate as it only captures the effectiveness of specific carryover provisions relative to full symmetry.

The intuition behind these two indices can be summarised as follows:

- The stabilisation index, A^{CF} captures the proportion of an adverse revenue shock (on loss-making firms) which is absorbed by the corporate tax system. A stabilisation effect of, for example, 28% implies that if a firm faces a reduction of EUR 100 in revenue its cash flow will decrease by only EUR 72.
- The symmetry index, S^{CF} captures the degree to which the corporate tax system allows for intertemporal loss offsetting. A value of zero implies that tax losses cannot be offset against the taxable income of other periods; whereas a value of one implies that tax losses can be offset intertemporally without losing any of their value. For example, if the symmetry index is 80%, a firm can expect to offset 80% of any tax losses incurred over time.

The definition of these indices can be illustrated on the basis of the following formal analysis. To simplify, we do not use firm-level subscripts, considering the cash flow of only one loss-making firm over time. The cash flow of this firm in period t , CF_t , depends on three components: revenues net of variable costs and depreciation, R_t , fixed costs, C_t^f , and current corporate income tax payments, $T_t = T_t(\cdot)$.

$$CF_t = R_t - C_t^f - T_t(\tau, R_t, R_{t-1}, \dots, R_1, D_t, \dots, D_1) \quad (1)$$

Current tax payments are a function of the statutory corporate income tax rate, τ , as well as current and past taxable income, depending on the number of years tax losses can be carried back or forward. In

particular, taxable income is determined for each period by taking into account total deductions, $D_t = a_t + l_t$, including³ capital allowances, a_t , and offset tax losses l_t .

The effect of a given shock on the net present value of revenues, denoted as dR , on the net present value of the firm's cash flow, dCF , depends on the magnitude of the shock itself as well as on the reduction in the net present value of tax liabilities resulting from the shock. Dropping time-subscripts to denote net present values, the change in cash flow can be written as follows.

$$dCF = dR \left(1 - \frac{\partial T(\cdot)}{\partial R} \right) \quad (2)$$

In other words, reductions in tax liabilities caused by a given exogenous shock mitigate the effects on the firm's cash flows. While this effect will always be equal to the statutory rate for profitable firms, for loss-making firms it is determined by the tax treatment of losses. Since each corporate tax system applies a different set of provisions, especially regarding intertemporal loss offsets, for loss-making firms the responsiveness of tax payments to changes in revenue, $\partial T(\cdot)/\partial R$, varies considerably across OECD countries. The stabilising effect of the corporate tax system on firm-level cash flow can then be defined as follows.

$$A^{CF} = \frac{dR - dCF}{dR} \quad (3)$$

That is, the degree to which the corporate tax system absorbs exogenous shocks to a loss-making firm's cash flow is measured as the difference between the change in revenues and the resulting change in cash flow as a proportion of the initial revenue shock. As discussed in the previous section this index approaches the statutory corporate tax rate as loss carryover provisions approach perfect intertemporal offsetting. If there is perfect loss offsetting, a drop in revenues by EUR 100 will decrease the tax liability exactly by the statutory corporate tax rate, τ . Intuitively, if the corporate statutory tax rate is 30%, for a EUR 100 loss, the government will allow the firm to offset future profits by EUR 100 and the firm will save EUR 30. This implies that $\partial T(\cdot)/\partial R = \tau$. Substituting into (2) and (3), we get $A^{CF} = \tau$.

In a system that does not allow for intertemporal offsetting, $\partial T(\cdot)/\partial R = 0$ for loss-making firms, the reduction in cash flow will be equal to the revenue shock, thus implying zero automatic stabilisation ($A^{CF} = 0$). As will be seen subsequently, actual corporate tax systems in OECD countries achieve values between these two extreme points.

While the index A^{CF} captures the stabilising effects of corporate tax, it is clear from the previous discussion that this effect captures only one channel through which investment may be affected. In order to pick up the direct effects of carryover provisions on investment through expected returns it is therefore more instructive to isolate the degree of symmetry achieved by different corporate tax systems. To this end we define a second tax index on the basis of the net present values of total deductions under the two extreme cases, D^{MAX} and D^{MIN} , corresponding to either perfect or no intertemporal loss offsetting.

$$S^{CF} = \frac{D - D^{MIN}}{D^{MAX} - D^{MIN}} \quad (4)$$

This index thus compares the generosity of actual total deductions in net present value terms, D , to its potential maximum given perfect loss offsets. For example, if total deductions have a net present value of EUR 30 and EUR 20 with and without intertemporal loss offsets, respectively, and the actual provisions,

3. Although the analysis could, in principle, be extended to cover tax credits and possibly other deductions, we do not cover these topics in this paper.

including less than perfect loss offsets, provide for deductions with a net present value of EUR 25, the tax symmetry index is 50%. This definition ensures that existing carryover provisions can be measured on a scale from zero to one.

4. Calculation and Simulation Procedures

Both tax indices are computed on the basis of a hypothetical investment project characterised by a set of economic assumptions. Specifically, we assume that, in each period, revenues net of depreciation, R_t , are determined by the capital stock, K_t , the pre-tax rate of return, p , and inflation, π .

$$R_t = (1 + \pi)pK_t \quad (5)$$

The capital stock, K_t , is assumed to be one in the first period, depreciating geometrically until it is fully depleted. Project lifetimes⁴ will thus be determined based on assumptions about economic depreciation δ (see Section 5 for a discussion of the different types of assets used for the calculations).

$$K_t = (1 - \delta)K_{t-1} \quad (6)$$

The remaining value of the investment for tax purposes, K_t^{TAX} , is determined through each period's capital allowances, a_t , which follow either a straight line or a declining balance schedule. Period-by-period allowances are thus determined based on the corresponding rate φ .

$$K_t^{TAX} = K_{t-1}^{TAX} - a_t \quad \text{where } a_t = \{a_t^{SL}, a_t^{DB}\} \quad (7)$$

$$a_t^{SL} = \varphi^{SL} K_1^{TAX} = \varphi^{SL} \quad (8)$$

$$a_t^{DB} = \varphi^{DB} K_{t-1}^{TAX} \quad (9)$$

To account for loss making we assume that revenue shocks occur, implying that the pre-tax rate of return, p , turns negative for a predefined number of periods. As can be seen from equation (5), this can imply that revenues are negative and firms make losses. If carrybacks are possible, firms can immediately obtain a tax offset corresponding to the tax loss incurred in the current period; to calculate this offset current tax losses are carried back and deducted against the taxable income of previous years. Since the offset is immediate, firms always prefer to carry tax losses backward rather than forward. If carryovers are possible, firms can accumulate tax losses, L_t , potentially including interest payments, $i^L \geq 0$, and subtracting offset tax losses, l_t .

$$L_t = -R_t + (1 + i^L)L_{t-1} - l_t \quad \text{if } R_t < 0 \quad (10)$$

If firms are again profitable they can offset accumulated tax losses, L_t , against current taxable income, thus increasing deductions in the respective period by the corresponding offset,⁵ $0 \leq l_t \leq \min[R_t - a_t, L_{t-1}]$. Under perfect loss offsetting, capital allowances which could not be claimed are thus carried forward as part of the tax losses implying that the net present value of capital allowances remains the same. However, restrictions to intertemporal loss offsetting may imply that parts of the capital allowances are lost.

4. It would be possible to extend the framework to account for permanent investments, e.g., by assuming that returns are reinvested to keep the capital stock constant. However, this is outside the scope of the paper.

5. It is always beneficial for the firm to offset tax losses in the earliest possible period. We therefore assume that firms offset as much of their accumulated tax losses as possible, given the taxable income of the respective period.

Tax payments are determined by subtracting total deductions, D_t , including capital allowances, a_t , and possibly offsets, l_t , from revenues, R_t , and multiplying by the corporate tax rate τ . As defined in equation (1), post-tax cash flow, CF_t , is then obtained by subtracting taxes from revenues.⁶

$$T_t = \max[0, (R_t - D_t)\tau] \quad (11)$$

$$CF_t = R_t - T_t \quad (12)$$

As discussed in Section 3 the two tax indices, A^{CF} and S^{CF} , are determined on the basis of the present values of the firm's revenues, net income, deductions and tax payments. We thus assume an exogenous real interest rate, r , determining the nominal rate as follows: $i = (1 + r)(1 + \pi) - 1$. The nominal interest rate is used for discounting, allowing for the calculation of the net present values of income net of depreciation, R , post-tax cash flows, CF , and total deductions, D , including capital allowances and loss offsets.

As highlighted in Section 4, for loss-making firms the responsiveness of tax payments to changes in revenue, $\partial T(\cdot)/\partial R$ depends on the tax treatment of losses. To determine the changes in revenues, dR , and cash flows, dCF , the calculation procedures outlined in this Section can now be used to determine net present values in two scenarios: one baseline without revenue shocks (where p is constant and positive) and one shock scenario (where p turns negative for a predefined number of periods). Taking simple differences between the baseline and the shock scenario then allows us to pin down dR and dCF accounting for the effects of country-level tax provisions. Similarly, the net present values of total deductions, D^{MAX} , D and D^{MIN} , can be calculated with perfect, imperfect and no loss offsets. Having derived these net present values the two tax indices can be calculated using equations (3) and (4).

To account for variation in revenue shocks we introduce a random variable, $\Delta \sim U(a, b)$ capturing possible losses as a proportion of the remaining capital stock, K_t . As discussed above, this definition implies that the rate of return, p , in equation (5) turns negative between periods u and $u + w$.

$$R_v^s = (1 + \pi)\lambda_s K_v \quad \text{where } \lambda_s < 0 \text{ and } u < v < w \quad (5-a)$$

When revenues turn negative, the tax liability is zero and tax losses accumulate according to equation (10), affecting, in turn, tax liabilities and cash flows in future periods through equations (11) and (12). While capital allowances will also have to be carried forward, depreciation of the capital stock is not affected by revenue shocks.

As will be discussed in Section 5, the timing of the revenue shocks must be aligned with other dimensions of the investment project, ensuring that starting periods, u , and durations, w , are such that the entire shock occurs within the lifetime of the project. Given the total set of admissible starting periods and durations an equal probability is assigned to each combination. In order to account for the most general set of shocks we also assume that losses are uniformly distributed over an interval (a, b) . Taking a series of random draws we can then derive a set of shocks $\lambda_s = \{\lambda_1, \dots, \lambda_S\}$ which may occur, with equal probability, with various lengths and at different times during the entire lifetime of the investment project.

For each of the shock scenarios, $s = 1, \dots, S$, the relevant net present values are calculated as described above and compared to the same baseline scenario. Averaging over the entire set of stabilisation and symmetry indices then yields the simulated tax indices⁷ $\bar{A}^{CF}$ and $\bar{S}^{CF}$.

6. Fixed costs of investment are assumed to be one, corresponding to the initial level of the capital stock.

7. A short description of the calculation procedures, based on a set of examples, is also included in Appendix A.

$$\bar{A}^{CF} = \frac{1}{S} \sum_{s=1}^S \frac{dR^s - dCF^s}{dR^s} \quad (13)$$

$$\bar{S}^{CF} = \frac{1}{S} \sum_{s=1}^S \frac{D^s - D^{s,MIN}}{D^{s,MAX} - D^{s,MIN}} \quad (14)$$

Being based on a hypothetical investment project our approach is thus conceptually similar to standard effective tax rate calculations (as described e.g., by Devereux and Griffith, 1999, 2001). However, in this paper we do not study the implications of revenue fluctuations and loss offsets at the firm-level (as captured by effective tax rates), focusing instead on macroeconomic implications on stabilisation and tax symmetry.

5. Stabilisation and Symmetry in OECD and Non-OECD Countries

Having laid out the conceptual framework, we now proceed by analysing the effects of loss carryover provisions on the two tax indices, stabilisation $\bar{A}^{CF}$ and symmetry $\bar{S}^{CF}$, in 34 OECD and non-OECD countries. Table 1 summarises the tax treatment in the countries for which data were collected. Emphasis was given to general carryover provisions. Group consolidation regimes and loss-related anti-avoidance rules such as rules targeting multinational tax avoidance or the shifting of tax losses from the company to the shareholder level are not within the scope of this analysis.

A total of 18 countries allow companies to claim loss carry-forwards indefinitely in the future, 11 countries limit the amount of deductions which can be claimed against taxable income in any given year (including 5 countries with infinite carry-forward periods). While 7 countries – Canada, Finland, Iceland, Japan, Mexico, Portugal and the United States – allow for limited but comparatively long carry-forward periods (10 or more years), a total of 9 countries opted for shorter carryover periods (between 0 and 9 years). In 2015, only Chile used to provide unlimited carry-backs; however, this provision has been repealed as of 2017. The majority of countries do not even allow taxpayers to carry-back unused tax losses. Canada, France, Germany, Ireland, the Netherlands, Singapore, the United Kingdom and the United States allow carry-backs for between 1 and 3 years. However, the fact that only Chile and Mexico index loss carry-forwards to inflation, implies that intertemporal offsetting will be less than perfect, especially when inflation and thus the nominal interest rate are high. Although this may not be a problem for countries and periods with low inflation, the effects will be significantly different from perfect loss offsets when inflation is high.

To derive the two tax indices, we first define the general characteristics of the investment project. Specifically, we assume a 30% rate of return (p), 5% real interest rate (r) and zero inflation⁸ (π). CIT rates (τ) are taken from the OECD Tax Database, using combined central and sub-central rates. To analyse interaction effects with economic and fiscal depreciation we define three generic asset types corresponding to non-residential buildings, machinery and equipment as well as intangibles. Each of the assets is defined in terms of an economic depreciation rate (δ) and fiscal depreciation rules consisting of a recovery method, straight line (SL) or declining balance (DB), and a capital allowance rate (φ).

For each of the three asset types, parameter values are chosen based on stylised results from a recent OECD questionnaire⁹ on tax depreciation rules in the corresponding set of countries. While the questionnaire provides more fine-grained information on depreciation parameters at the asset-level, the

8. We assume zero inflation in order to focus attention on the effects of loss carryover provisions.

9. The questionnaire was sent to tax policy officials from 42 OECD and Non-OECD countries in March 2016; apart from loss carryover provisions it also asked for detailed information about country-level depreciation rules.

parameters underlying this analysis correspond to the median rules in each of the three broad asset categories across the sample of 34 countries: non-residential structures, manufacturing and equipment, intangibles. The first asset category, non-residential buildings, is characterised by an economic depreciation rate δ of 3% and fiscal depreciation based on a straight line schedule with a 3% capital allowance, implying that tax depreciation is only slightly accelerated. The second asset category, machinery and equipment, has an economic depreciation rate of 8% while fiscal depreciation is accelerated using a 16% declining balance schedule. The third asset category, intangibles, depreciates at a rate of 10% and is assumed to be expensed immediately, corresponding to cash flow taxation. While it is a well-established fact that cash flow taxes do not distort investment decisions, this property holds only if the firm earns sufficient net income to immediately offset all of its deductions or if there are perfect intertemporal loss offsets (including indexation).

Although we do not explicitly account for country-level depreciation rules,¹⁰ the asset definitions roughly correspond to the median rules in each asset category across the sample of 34 countries. Holding country-level depreciation rules constant across jurisdictions is preferable in our context. This approach allows us to isolate the effects of different loss carryover provisions taking into account interactions with stylised depreciation rules as described above; however, to the extent that there is interaction between depreciation rules and carryover provisions at the country-level, any such effect will not be picked up by our indices.

10. It would have been possible to model asset types accounting for country-specific tax provisions; however, we chose to use generic asset types in order to ensure a *ceteris paribus* comparison of loss offset rules across countries.

Table 1: Loss Carryover Provisions in OECD and Non-OECD Countries (1 July 2015)

Country	Carry-Forward	Carry-Back	Limit to Deductability of Tax Losses
Australia	unlimited	0	
Austria	unlimited	0	Reduction of max. 75% of taxable income per year
Belgium	unlimited	0	
Canada	20	3	
Chile	unlimited	unlimited	
Costa Rica	3	0	(1)
Czech Republic	5	0	
Denmark	unlimited	0	
Finland	10	0	
France	unlimited	1	Deductions above EUR 1 million are restricted to 50% of taxable income per year (2)
Germany	unlimited	1	Deductions above EUR 1 million are restricted to 60% of taxable income per year (2)
Greece	5	0	
Hungary	5	0	Reduction of max. 50% of taxable income per year (3)
Iceland	10	0	
Ireland	unlimited	1	
Israel	unlimited	0	
Italy	unlimited	0	Max. 80% of taxable income (100% for losses referring to the first 3 years) (4)
Japan	10	0	(5)
Luxembourg	unlimited	0	
Mexico	10	0	
Netherlands	9	1	
Norway	unlimited	0	
Poland	5	0	Max. 50% of accumulated tax losses per year
Portugal	12	0	Reduction of max. 70% of taxable income per year
Singapore	unlimited	1	
Slovak Republic	4	0	Max. 25% of accumulated tax losses per year
Slovenia	unlimited	0	Reduction of max. 50% of taxable income per year
South Africa	unlimited	0	
Spain	unlimited	0	Max. 60% (2016) and 70% (2017+) of the taxable base before the capitalization reserve per year (6)
Sweden	unlimited	0	(7)
Switzerland	7	0	
Turkey	5	0	
UK	unlimited	1	
USA	20	2	

Notes: (1) In Costa Rica carry-forwards are limited to 3 years for industrial and 5 years for agricultural companies; the following analysis assumes that the rule for industrial companies applies. (2) In cases where restrictions to deductibility apply only above a certain threshold we assume that they are not binding. (3) In Hungary, taxpayers operating in the agricultural sector may deduct the amount of the deferred loss from the pre-tax profit of the preceding two tax years; however, the deduction cannot exceed 30% of taxable income of the respective tax year. (4) In Italy net operating losses can be carried forward for an unlimited number of years up to 80% of the corporate taxable income in the tax period of utilization of the losses (100% if losses are referred to the first three years of business and relate to a new production activity). (5) In Japan tax loss related deductions of large companies are restricted to 65% of taxable income in 2016, with this limit being further reduced to 50% starting from fiscal year 2017; however, since the vast majority of companies in Japan is not considered to fall into this category our calculations assume that this limit does not apply. (6) In Spain deductibility of tax losses is limited to a maximum of 60% (2016) and 70% (2017+) of the taxable base before the capitalization reserve provided for in Article 25 of the Corporate Income Tax Law and before offsetting any negative tax bases.

Recently, in the case of large companies, Royal Decree Law 3/2016, of 2nd December reduced, as regards taxable periods beginning from 1st January 2016, the upper limits to offset negative tax bases as follows: (i) The limit shall be 50% where in the 12 previous months, at the beginning of the taxable year, the net turnover is at least EUR 20 million, but less than EUR 60 million; (ii) the limit shall be 25% where in the 12 previous months, at the beginning of the taxable year, the net turnover is at least EUR 60 million. (7) In Sweden the tax allocation reserve allows firms to put up to 25 per cent of pre-tax income into an untaxed reserve. This can be done for up to six years. The funds from the tax allocation reserve can be used to quit against losses that occur in a later year. The tax allocation reserve thus allows some carry-back of losses.

Our analysis uses hypothetical investment projects as a benchmark; we do not estimate aggregated tax losses at the firm level, nor do we attempt to model firm level decisions about the optimal utilisation of tax losses. As a consequence, we cannot reproduce observed levels of unused or expiring tax losses in any particular country. Instead, our analysis focuses on evaluating the impact of specific provisions on a firm's ability to recoup tax losses on the basis of a predefined investment project. Holding the investment project constant we can then study the effectiveness of specific sets of carryover provisions in the context of different types of shocks.

In line with this approach, we align the definition of the revenue shocks with assumptions about the profitability of the investment projects. In that way, we ensure that tax losses do not expire unused at the end of the project, thereby causing unintended interaction effects with the two tax indices. In particular, net present value calculations are based on the cash flows associated with one specific investment in a given type of asset. Since capital stocks deplete over time, each investment project is characterised by a finite lifetime which generally depends on the initial investment level as well as the rate of economic depreciation. As a consequence, the number of periods in which a firm can offset accumulated tax losses is restricted to the lifetime of the respective asset. Other parameters held constant, it will be easier for firms to offset all of their accumulated tax losses when projects are more profitable, that is, when economic depreciation is lower, project lifetimes are longer and rates of return are higher. Adjusting the size and timing of the shocks such that they are proportional to the overall profitability of the project therefore ensures that no unused tax losses are left at the end of the investment project.

An alternative approach would be to assume that firms reinvest some of their returns to keep the capital stock constant, implying that cash flows need to account for reinvestments and depreciation allowances associated with different vintages of the capital good.¹¹ Under these assumptions the time horizon is infinite and firms will always be able to offset accumulated tax losses against future income. However, to ensure comparable results across different assets, the calculations would need to be based on a more complex model of the firm including further assumptions about financing and reinvestment. While this approach may have certain advantages with regard to explaining observed levels of tax losses at the firm level, our approach aims only at isolating the effects of differences in the tax treatment of losses. As a robustness check, to make sure that assumptions about project lifetimes do not drive our results on loss carryover rules, we also simulate a reinvestment scenario, for each of the three assets, corresponding to the case where the capital stock is kept constant and project lifetimes therefore do not affect the firms' capacity to offset accumulated tax losses. The results from these simulations show that this alternative assumption does not affect the main conclusions presented in the following paragraphs (see Appendix B).

Investments in different asset types may produce different rates of return; however, to ensure comparability across assets, we assume a comparatively high rate of return, $p=30\%$, and define the range of possible shocks such that tax losses can always be offset within the lifetime of the project. In particular, we

11. Since the returns from investments are the same in every period, this approach would make it easier for firms to offset tax losses accumulated in previous periods. For instance, if a firm experiences four periods of 5% losses (relative to a capital stock that is now always equal to one) it will accumulate 20 units of tax losses when it becomes profitable again (assuming an initial investment of 100 units). In the case of a 20% rate of return it could thus offset its entire accumulated losses in just one period.

define Δ to be uniformly distributed over the interval $\{-0.01, -0.2\}$, implying that in each of the loss periods, firms will make losses between 1% and 20% of their capital stock (as defined in equation (5-a)). Possible shock durations, w , and starting periods, u , are also randomised, giving equal probability to each of the possible starting periods 1 to 4 as well as the possible durations of 2 to 6 periods. As a result, shock periods are confined to the first ten periods of the project but varying with regard to timing and severity. Project lifetimes, on the other hand, are much longer for all three assets ensuring that no unused tax losses remain.¹² Taking 10% of the original investment value as the threshold where the remaining tax value is written off, intangibles have a lifetime of 24 periods, machinery and equipment 30 periods and non-residential buildings 75 periods.

Figure 1. Stabilisation Effects on Investments in Non-residential Structures

Stabilisation Effects

Figure 1 shows the result for the stabilisation index for the first asset category, non-residential structures. Countries are ranked by their combined central and sub-central corporate income tax rates in 2015, corresponding to the dark blue marker. Stabilisation effects, as captured by $\bar{A}^{CF}$ are summarised through box plots. Only corporate tax rates and carryover rules vary across countries. However, for each country the stabilisation index has been calculated for 1000 different shocks which have been derived based on random draws from the distributions described in the previous paragraph.¹³ Each box plot shows the maximum and minimum values (i.e., the upper and lower whisker) as well as the 25th, 50th and 75th

12. If longer or later shock periods were assumed finite project lifetimes may imply that the investment is fully written off before accumulated losses have been offset. The shock definition thus ensures that assumptions about asset lifetimes and profitability do not affect the results.

13. The shocks are also kept constant across countries, assets and tax indices.

percentiles (i.e., the lower, middle and upper line in the light blue box) of the distribution of stabilisation (or symmetry) effects. More spread out box plots therefore imply that there is more variation in symmetry and stabilisation effects given the country-specific tax treatment of losses; this will be the case, for instance, when carryover provisions are such that a significant amount of tax losses or depreciation allowances expire unused under certain, but not all, types of shocks. Taking Germany as an example, Figure 1 shows that stabilisation effects are just below 30% for 75% of the shocks (i.e., the lower edge of the light blue box is very close to 30%). In the case of the Slovak Republic, the box is much wider, implying that there is more variation and that stabilisation effects are spread out between 18% and 20% for about 75% of the shocks.

As expected, headline tax rates represent an upper limit to the simulated stabilisation index. If intertemporal loss offsets were perfect, in the sense defined in Section 2, the corporate tax system would be perfectly symmetric, $\bar{S}^{CF} = 100\%$, and stabilisation would be equal to the statutory rate, $\bar{A}^{CF} = \tau$. Figure 1 shows that this is generally not the case. Several results stand out. First, for assets subject to depreciation schedules with limited acceleration, simulated stabilisation indices are quite close to the upper limit, the statutory rate, in the majority of countries. This can be seen in Figure 1 by comparing the position of the box relative to the dark blue marker. If the box is close to the upper limit, stabilisation effects are concentrated just below the statutory rate for three quarters of the shocks since the lower edge of the box represents the 25th percentile. If the box or the whiskers are longer, the stabilising effects of carryover provisions vary much more with the type of shock.

Second, it is expected that stabilisation effects will be lower if losses are larger and when shock periods last longer or arrive earlier in the project lifetime. However, since all countries are subject to the same shocks in the simulations, the different shapes of the box plots show that the same types of revenue shocks can have very different effects depending on the different carryover provisions. For instance, there are some countries for which stabilisation effects are much lower for a significant number of shocks. This effect is especially striking for Hungary, the Slovak Republic and Costa Rica. Comparing the carryover rules in these countries shows that this result is driven by a combination of limited carryforward periods and strict offsetting limits (see Table 1). In Hungary, for instance, 5 carryforward years are granted and offsets are limited to 50% of taxable income every year. The combination of the former two provisions implies that stabilisation is low in many cases. The Slovak Republic combines 4 years of carryforwards with a 25% limit to offsets as a proportion of accumulated tax losses. The result is that stabilisation is substantially lower than the statutory rate for the majority of simulated shocks. Costa Rica does not limit offsetting, however, it only provides three years of carryforwards, implying that some of the accumulated tax losses are lost when this limit is reached. Consequently, stabilisation indices are lower in the case of longer and more severe revenue shocks as well as in cases when shocks arrive earlier during the project lifetime.

A third result emerging from Figure 1 is that carrybacks appear to be an effective policy tool in moving stabilisation effects close to the upper limit, even if tax losses are not indexed to inflation. In all 9 countries with carrybacks, Canada, Chile, France, Germany, Ireland, Netherlands, Singapore, the United Kingdom and the United States, the stabilisation index is very close to the statutory rate for at least 25% of the simulations. As a result, in Figure 1, for each of the 9 countries, the upper end of the box is basically equal to the statutory rate. Since this is true for all 9 countries this result also suggests that, given the size of the simulated revenue shocks, one year of carryback is, in most of the cases, sufficient to achieve higher stabilisation effects. In the two countries where tax losses are indexed, Chile and Mexico, the maximum stabilisation effect can be reached in all of the simulated scenarios (i.e. the box collapses into the dark blue marker).

Figure 2. Stabilisation Effects on Investment in Machinery and Equipment

Ranked by Statutory Corporate Income Tax Rates (Dark Blue)

Figures 2 and 3 depict the results for the other two asset categories, corresponding to faster economic depreciation and more accelerated tax depreciation rules. For a profitable firm, accelerated depreciation spreads the tax value of an asset over a shorter period of time and it is therefore always beneficial due to the time value of money. For a loss-making firm, however, this is not generally the case because carryover rules are imperfect and depreciation allowances, which are typically carried forward as part of the tax losses, could expire unused.

Accelerated depreciation implies that larger shares of the initial investment are deducted in earlier periods of the project. The effects on the two tax indices therefore differ depending on the timing of the shocks. If tax depreciation is accelerated, larger deductions can be claimed in earlier periods, implying that revenue shocks in earlier periods of the project will have more negative effects on both tax indices compared to cases without acceleration. However, if shocks happen late during the project lifetime a larger share of depreciation allowances has already been claimed. As a result, there will be fewer deductions to be carried forward and late shocks will have smaller effects on the two tax indices compared to assets which are not subject to accelerated depreciation. Taken together, accelerated depreciation increases the variation in both tax indices, implying that the box plots depicted in Figures 2 and 3 will be more spread out.

Results for machinery and equipment confirm this expectation. Figure 2 shows that for most countries the majority of stabilisation effects are still concentrated below the statutory rate, although the proportion of shocks which is completely cushioned is now lower in almost all countries (as indicated by the larger gaps between the box and the dark blue marker). In addition, there are several countries for which interactions between accelerated tax depreciation and carryover provisions lead to much lower stabilisation values in a substantial number of cases. For instance, the Czech Republic, Greece and Turkey all provide only 5 years of carryforwards; however, they do not restrict tax offsets. Figure 2 shows that this leads to much lower minimum values in all of these countries. This result is driven by two factors. First,

accelerated depreciation implies that larger deductions have to be carried forward if shocks hit early during the project lifetime. Second, stricter time limits on carryforwards imply that not all of the accumulated tax losses can be offset and a proportion of the total deductions expire unused. Since some of the simulated shocks arrive at later stages of the project there is, in these 3 countries, a substantial number of cases where stabilisation effects are still quite close to the statutory rate.

Portugal allows firms to carry tax losses forward for up to 12 years, that is somewhat longer than the 3 countries discussed in the previous paragraph; unlike them, however, it also limits offsets to 70% of taxable income per year. Figure 2 shows that this combination of carryover rules has a different impact on the distribution of stabilisation effects. As for the previous 3 countries, the Czech Republic, Greece and Turkey, the minimum value for Portugal is now lower than in the case without acceleration. However, since the offsetting limit can also become binding if shocks arrive at later stages of the investment project, this type of rule generally affects the whole distribution of tax indices. In Figure 2 this downward shift in the distribution of stabilisation effects is also visible in the case of Slovenia which allows for infinite carryforwards but restricts offsets to 50% of taxable income per year.

For the 3 countries with the most restrictive provisions, Costa Rica, Hungary and the Slovak Republic, the results are now even more pronounced. Hungary has 5 years of carryforwards and restricts tax offsets to 50% of taxable income per year. The combination of these two provisions implies that, compared to the other countries with 5-year carryforwards, the distribution of stabilisation effects is shifted away from the statutory rate. Costa Rica, on the other hand, does not restrict tax offsets but provides only 3 years of carryforwards implying that minimum values of the distribution are particularly low.

The Slovak Republic combines very strict limits on carryforwards and offsets. In particular, carryforwards are limited to 4 years and offsets to 25% of accumulated tax losses per year. As a result of this combination, the minimum value reached in the simulations is almost 10 percentage points below the statutory rate. Furthermore, the strict offsetting limit implies that the distribution of stabilisation effects is shifted downwards. Figure 2 shows that even the maximum stabilisation effect (i.e., the upper whisker) is now well below the statutory rate. A similar but less pronounced effect can be seen for Poland which allows 5 years of carryforwards and restricts offsets to 50% of net operating losses, causing a significant downward shift in the distribution of stabilisation effects.

Results for intangibles, depicted in Figure 3, confirm that interactions between accelerated tax depreciation and carryover provisions may be considerable. In contrast to Figure 2 the main difference is that intangibles are assumed to be expensed (i.e., fully written off in the first period). The timing of the shock therefore has even stronger effects on the two tax indices, contributing to the increase in variation in the stabilisation indices depicted in Figure 3.

If the shock hits in the first period of the project lifetime the entire investment cost has to be carried forward and claimed against future income. As a result, limits to carryforward years and offsetting now have stronger effects on both tax indices. In Figure 3, the effects are most visible for those countries with the most restrictive sets of rules, including Costa Rica, Hungary and the Slovak Republic. In the first two of these countries, there may be almost no stabilisation effects for certain types of shocks, i.e., when long loss-periods occur in the early stages of the investment project. On the other hand, if the shock hits in a later period of the project lifetime a larger share of the depreciation allowances has already been claimed; in this case the impact on the tax indices may be comparatively low as indicated by the fact that in Figure 3 the upper whiskers often coincide with the statutory rate.

In the Czech Republic, Turkey and Greece the effects of their 5-year limit on carryforwards are now also more pronounced. Consistent with the results in Figure 2, time limits do not shift the bulk of the distribution, but have strong impacts on the minimum values. This effect can also be seen for Switzerland

and the Netherlands, which provide 7 and 9 carryforward years respectively. In contrast, the downward shifting effect of offsetting limits now becomes more visible, for instance, for Austria, Italy, Portugal, Slovenia and Spain.

Figure 3. Stabilisation Effects on Investment in Intangibles

Ranked by Statutory Corporate Income Tax Rates (Dark Blue)

As discussed in Section 2, the stabilisation effects, as defined by $\bar{A}^{CF}$, are closely related to the analyses presented by Devereux and Fuest (2009) and Buettner and Fuest (2010). In particular, both papers have assumed that corporate tax does not stabilise cash flows of loss-making firms (credit-constrained or not). However, our analysis shows that, given observed carryover provisions, it is likely that there are considerable stabilisation effects working also through this group of firms. As highlighted in their alternative simulation, Buettner and Fuest (2010) show that the overall stabilisation effect is driven by the shares of credit-constrained and taxable firms. Their empirical analysis confirms that there are more credit-constrained but fewer taxable firms during recessions, implying counteracting effects on stabilisation. However, our results show that if carryover provisions are accounted for, stabilisation will be larger due to the effects of these provisions on credit-constrained, non-taxable firms.¹⁴

Tax Symmetry

Figures 4 to 6 show the simulated symmetry indices for each of the three assets. Since the two tax indices are intrinsically related, Figures 4 to 6 basically confirm the results discussed in the previous paragraphs. However, there are differences in the definition of the two indices. While stabilisation is measured in relation to the size of the revenue shock, symmetry is measured by comparing actual levels of

14. For instance, taking our results for Germany as a benchmark shows that total stabilisation effects during recessions are close to the perfect loss offset scenario in Buettner and Fuest (2010).

total deductions to their minimum and maximum values given a specific type of shock. This difference should be kept in mind when comparing the results across the two tax indices.

Given the types of simulated shocks, tax symmetry is generally quite close to perfect for non-residential structures (Figure 4). As before, the two countries with indexation adjustments, Chile and Mexico, achieve full symmetry in all simulated scenarios. Of the remaining countries, those providing 1 or more years of carrybacks (i.e., Canada, France, Germany, Ireland, Netherlands, Singapore, the United Kingdom and the United States) achieve the highest median values. Canada and the United States provide more than one year of carrybacks and their symmetry levels are above 95% for around 75% of the simulated shocks (i.e., the box plots are skewed towards the top of the scale), while the other 6 countries with only one year carryback provisions rank slightly below.

Figure 4. Tax Symmetry for Investments in Non-residential Structures

For the bulk of the countries, median tax symmetry is at around 90%. Again, offsetting limits, as in Austria, Italy, Portugal, Spain and Slovenia imply that the median symmetry levels achieved in the simulations is somewhat lower than for countries without such limits; the 3 carryforward years provided in Costa Rica have a strongly negative effect on tax symmetry. The Slovak Republic again stands out as it provides only 4 years of carryforwards and applies a 25% offsetting limit, defined in proportion to accumulated tax losses. The consequence is that, irrespective of the type of the shock, only a comparatively small fraction of total deductions will be offset against taxable income before such deductions expire. Poland combines 5 years of carryforwards with a 50% offsetting limit also defined with reference to accumulated tax losses per year. As in the Slovak Republic the distribution of tax symmetry values is shifted downwards with a median value just below 85%. Since only these two countries define offsetting limits relative to accumulated tax losses, Figure 4 suggests that this definition is more restrictive than the standard restriction in terms of taxable income.

Figure 5 shows results for machinery and equipment. Interaction effects between accelerated tax depreciation and carryover provisions imply that the distribution of tax symmetry indices is now more dispersed in all countries. Effects of more restrictive combinations of carryover rules become more apparent, as is the case for Costa Rica, Hungary and the Slovak Republic. For countries with fewer carryforward years, such as the Czech Republic, Greece and Turkey, the minimum value decreases further; while those with offsetting limits, Austria, Italy, Portugal, Spain and Slovenia experience an increase in the dispersion of the symmetry index. Dispersion increases, in particular, for the Slovak Republic and Poland, the two countries with lower maximum symmetry levels. However, carrybacks are still effective in increasing tax symmetry indices at the top end of the distribution.

Figure 5. Tax Symmetry for Investments in Machinery and Equipment

Tax symmetry effects for expensed intangibles are shown in Figure 6, keeping the country ranking stable for ease of comparison. Except for the two countries with indexation adjustments, maximum symmetry levels have now declined from 95% to 100% in Figure 5 to just above 90% in Figure 6. This is due to two effects. First, the total amount of deductions which have to be carried forward is higher for expensed assets, independent of the timing of the shock, because profits in the first period may not be high enough. Since most countries do not index tax carryforwards the maximum symmetry levels decrease. Second, the effect of carrybacks is also reduced. This is the case because higher deductions in the first period of the project make it less likely that profits are high enough to utilise available carrybacks implying that a fraction will have to be carried forward to later periods.

As in Figure 5, minimum symmetry levels have further decreased compared to non-residential structures. This effect is now especially striking in countries allowing for fewer carryforward years such as Costa Rica and the Slovak Republic. For these two countries, variation in tax symmetry has increased considerably in line with the fact that the timing of the shock now has more important implications for the

firm's capacity to offset their deductions. A similar but less strong effect can be observed for countries with only 5 carryforward years, the Czech Republic, Greece, Poland and Turkey.

Maximum symmetry levels are lower for countries where offsetting limits exist, including not only the Slovak Republic and Hungary but also Austria, Slovenia, Italy, Poland, Portugal and Spain. This is due to the fact that the amount of deductions to be carried forward has now increased. Therefore, limiting the yearly amounts of tax offsets implies that a part of their value will be lost irrespective of the type of shock. As a result, the distribution of symmetry indices is shifted downward in these countries.

Figure 6: Tax Symmetry for Investments in Intangibles

6. Policy Conclusions

In this paper we analyse the effects of various carryover provisions on tax symmetry and stabilisation across a total of 34 OECD and non-OECD countries. Our tax symmetry index captures the effectiveness of actual carryover provisions, including carryforwards and carrybacks, relative to full symmetry. The stabilisation index, as defined in our paper and in line with the previous literature, captures the proportion of an adverse revenue shock on loss-making firms which is absorbed by the corporate tax system.

Loss carryover rules generally have important implications for investment. On the one hand, they help cushion the effects of adverse revenue shocks on the cash flows of loss-making firms, potentially affecting investments of credit-constrained firms. On the other hand, they affect the choice of investment projects with different risk profiles. Based on these considerations we have defined two tax indices capturing effects of carryover provisions on stabilisation and symmetry of corporate taxation.

To analyse the performance of each system we use a simulation approach, calculating both indices for a set of 1000 adverse random shocks to firms' revenues. Investment projects vary with regard to economic

and tax depreciation and the shocks are calibrated such that tax losses do not expire unused at the end of the project.

Based on this approach we are able to discern a number of insights.

- For assets which are only subject to moderately accelerated depreciation, existing carryover rules produce upper bound estimates relatively close to full tax symmetry in most of the 34 countries. Given our methodological approach this implies that corporate tax systems are effective in reducing the negative effects arising from an asymmetric tax treatment of corporate losses and gains.
- Allowing firms to carry tax losses forward and offset them against future income is the most important policy tool to achieve this result. Ideally, infinite carrybacks and carryforwards should be provided and tax losses should be indexed to inflation to maintain their real value over time. In this case corporate taxation would be symmetric, removing tax-induced distortions towards less risky projects and increasing (potential) stabilisation effects. On aggregate, such a policy therefore supports an efficient allocation of investment funds and increases the resilience of the economy during protracted downturns. However, given that infinite loss carrybacks might be problematic with respect to fraud this result needs to be evaluated carefully.
- In our sample of 34 countries only 18 provide infinite carryforwards and most countries do not index tax losses; perfect tax symmetry is therefore not achieved by the majority of countries, although the lack of indexation is likely to be less significant in an environment where inflation and nominal interest rates are low.
- Most countries do not index tax losses carried forward to inflation. However, the simulations presented in this paper show that, for tax depreciation schedules which are not too accelerated, carrybacks are an effective policy, which helps to move symmetry and stabilisation indices towards their full potential even in the absence of indexation.
- 16 countries limit carryforward periods to between 3 and 20 years. Our simulations show that this type of limitation reduces the minimum symmetry and stabilisation values achieved by a given system. A time limit on the number of years that firms can carry forward their tax losses implies that tax symmetry and the corresponding stabilisation effects can become very low for firms which remain in a loss position for more than just one or two years. Given that the simulated shocks varied between 2 and 6 years, limiting carryforwards to below 10 years led to substantial reductions in both indices.
- 8 countries limit the amount of tax losses which can be offset in any given year. The effects of this type of provision are different compared to the effects of time limits. While time limits have stronger negative effects under specific conditions (e.g., when loss periods are longer), limiting the amount of offsets that firms can deduct in any given period implies that a much larger share of firms will be affected, especially when there is no indexation. This type of provision therefore shifts the entire distribution of symmetry and stabilisation values downwards.
- The definition of the limits imposed on tax offsets can have strong impacts on the two tax indices. For example, the Slovak Republic and Poland define their offsetting limit in relation to accumulated losses (i.e., 25% and 50% respectively). Defining tax offsetting limits in this way can have a more negative effect on the two indices compared to the 6 countries where taxable income is used as a reference point.

- There can be important interactions between carryover provisions and accelerated depreciation. Since depreciation allowances are typically carried forward as part of tax losses, more acceleration implies that the variation in simulated tax indices increases. For instance, if depreciation allowances are larger at the beginning of a project, the restrictions on carryforward years and offsets can become much more relevant in cases where the loss periods coincide with the initial investment. On the other hand, the effects will be smaller if loss periods occur towards the end of the project when most of the depreciation allowances have already been claimed.
- Immediate expensing of capital investments, corresponding to cash-flow taxation, implies that full tax symmetry cannot be achieved in any of the countries analysed and for any type of revenue shock. While carrybacks counteract the lack of indexation for tax systems utilising asset depreciation, immediate expensing increases the share of the initial investment which has to be carried forward, thus also increasing the value lost due to imperfect offsetting. Since it becomes more difficult to reach full tax symmetry under a tax system relying on immediate expensing, it is important to grant full loss offset under a cash flow tax in order to preserve the non-distortive properties of cash flow taxation.
- Previous estimates of the stabilising effects of corporate tax are likely to be biased downwards due to the failure to account for carryover provisions. Research by Buettner and Fuest (2010) shows that accounting for carryovers would have increased total stabilising effects on investment in a recent recession in Germany in 2003 by an upper bound of 7 percentage points.

Future research in this area could expand the approach followed in this paper along several dimensions. First, the level of analysis could be shifted from assets to firms, assuming that firms invest in asset mixes and replace depreciated assets over time. Although this approach will make it more difficult to isolate the effects of different carryover rules, it could provide a suitable starting point for an empirical analysis of the observed accumulation of tax losses over the business cycle. Second, the approach could be further expanded to take into account country-specific data on tax losses and revenue shocks. Using, for instance, firm-level data from ORBIS, revenue shocks could be calibrated to match observed patterns, thus increasing the explanatory power of tax indices in the context of cross-country analyses of investment decisions. Finally, the simulation approach could be further developed by calculating simulated average and marginal effective tax rates comparable to the standard approach by Devereux and Griffith (1999, 2003).

APPENDIX

A. Calculation Procedures

Calculation procedures can be illustrated on the basis of period-by-period cash flows as depicted by Tables 2 to 4. All three tables are based on the same set of parameter values: 20% rate of return, 10% economic depreciation, 10% declining balance capital allowance and a 30% corporate tax rate. Table 2 shows the baseline scenario, where the rate of return is always positive; it is used to calculate the net present values of pre-tax net income (1.33), total deductions (0.20) and post-tax cash flow (0.60).

Table 2: Period-by-period Cash Flows in the Baseline Scenario

Year	Investment	Capital	Real Depreciation	Revenue	Pre-Tax Net Income	Remaining Tax Value	Total Deductions	Taxable Income	Taxes	Post-Tax Cash Flow
0	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.00
1	0	1.00	0.10	0.30	0.20	1.00	0.10	0.20	0.06	0.24
2	0	0.90	0.09	0.27	0.18	0.90	0.09	0.18	0.05	0.22
3	0	0.81	0.08	0.24	0.16	0.81	0.08	0.16	0.05	0.19
4	0	0.73	0.07	0.22	0.15	0.73	0.07	0.15	0.04	0.17
5	0	0.66	0.07	0.20	0.13	0.66	0.07	0.13	0.04	0.16
6	0	0.59	0.06	0.18	0.12	0.59	0.06	0.12	0.04	0.14
7	0	0.53	0.05	0.16	0.11	0.53	0.05	0.11	0.03	0.13
8	0	0.48	0.05	0.14	0.10	0.48	0.05	0.10	0.03	0.11
9	0	0.43	0.04	0.13	0.09	0.43	0.04	0.09	0.03	0.10
10	0	0.39	0.04	0.12	0.08	0.39	0.04	0.08	0.02	0.09
11	0	0.35	0.03	0.10	0.07	0.35	0.03	0.07	0.02	0.08
12	0	0.31	0.03	0.09	0.06	0.31	0.03	0.06	0.02	0.08
13	0	0.28	0.03	0.08	0.06	0.28	0.03	0.06	0.02	0.07
14	0	0.25	0.03	0.08	0.05	0.25	0.03	0.05	0.02	0.06
15	0	0.23	0.02	0.07	0.05	0.23	0.02	0.05	0.01	0.05
16	0	0.21	0.02	0.06	0.04	0.21	0.02	0.04	0.01	0.05
17	0	0.19	0.02	0.06	0.04	0.19	0.02	0.04	0.01	0.04
18	0	0.17	0.02	0.05	0.03	0.17	0.02	0.03	0.01	0.04
19	0	0.15	0.02	0.05	0.03	0.15	0.02	0.03	0.01	0.04
20	0	0.14	0.01	0.04	0.03	0.14	0.01	0.03	0.01	0.03
NPV					1.33		0.20			0.60

Table 3 is based on the same parameter values, except for the revenue shock of 5% of the remaining capital stock during periods 2 to 5. Since no intertemporal loss offsets are allowed, the net present values change as follows: pre-tax net income (0.68), total deductions (0.12) and post-tax cash flow (0.10).

Table 3: Period-by-period Cash Flows in the Shock Scenario without Loss Offsets

Year	Investment	Capital	Real Depreciation	Revenue	Pre-Tax Net Income	Remaining Tax Value	Total Deductions	Taxable Income	Taxes	Post-Tax Cash Flow
0	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.00
1	0	1.00	0.10	0.30	0.20	1.00	0.10	0.20	0.06	0.24
2	0	0.90	0.09	0.05	-0.05	0.90	0.09	0.00	0.00	0.05
3	0	0.81	0.08	0.04	-0.04	0.81	0.08	0.00	0.00	0.04
4	0	0.73	0.07	0.04	-0.04	0.73	0.07	0.00	0.00	0.04
5	0	0.66	0.07	0.03	-0.03	0.66	0.07	0.00	0.00	0.03
6	0	0.59	0.06	0.18	0.12	0.59	0.06	0.12	0.04	0.14
7	0	0.53	0.05	0.16	0.11	0.53	0.05	0.11	0.03	0.13
8	0	0.48	0.05	0.14	0.10	0.48	0.05	0.10	0.03	0.11
9	0	0.43	0.04	0.13	0.09	0.43	0.04	0.09	0.03	0.10
10	0	0.39	0.04	0.12	0.08	0.39	0.04	0.08	0.02	0.09
11	0	0.35	0.03	0.10	0.07	0.35	0.03	0.07	0.02	0.08
12	0	0.31	0.03	0.09	0.06	0.31	0.03	0.06	0.02	0.08
13	0	0.28	0.03	0.08	0.06	0.28	0.03	0.06	0.02	0.07
14	0	0.25	0.03	0.08	0.05	0.25	0.03	0.05	0.02	0.06
15	0	0.23	0.02	0.07	0.05	0.23	0.02	0.05	0.01	0.05
16	0	0.21	0.02	0.06	0.04	0.21	0.02	0.04	0.01	0.05
17	0	0.19	0.02	0.06	0.04	0.19	0.02	0.04	0.01	0.04
18	0	0.17	0.02	0.05	0.03	0.17	0.02	0.03	0.01	0.04
19	0	0.15	0.02	0.05	0.03	0.15	0.02	0.03	0.01	0.04
20	0	0.14	0.01	0.04	0.03	0.14	0.01	0.03	0.01	0.03
NPV					0.68		0.12			0.10

Table 4 shows again the same scenario including the same revenue shock, but this time with perfect intertemporal loss offsets. Since the shock is the same the net present value of pre-tax net income is the same as in the second table (0.68). However, tax losses are now accumulated and offset as soon as taxable income allows. As a result, the net present values of total deductions (0.16) and cash flow (0.14) increase.

Having calculated net present values we can now calculate changes between the baseline scenario (without shocks) and the two scenarios with shocks. Subtracting the net present value of net income under the shock scenarios from the corresponding value under the baseline scenario yields $dR=0.66$. Subtracting the net present value of cash flow under the shock scenarios from the corresponding value under the baseline scenario yields $dCF=0.46$ (without loss offsets) and $dCF=0.50$ (with perfect loss offsets). Based on equation (3) the stabilisation effect without loss offsets is thus equal to 24% (smaller than the statutory corporate tax rate); with perfect loss offsets it is equal to 30% (the statutory rate).

Symmetry effects are based on the net present values of total deductions as defined in equation (4). In this example the net present value of total deductions is equal to 0.1211 in the case without loss offsets and 0.1605 in the case with perfect loss offsets. Switching off indexation shows that this value drops to around 0.1553, implying that the symmetry index (with unlimited loss offsets but without indexation) is around 86.8%.

Table 4: Period-by-period Cash Flows in the Shock Scenario with Perfect Loss Offsets

Year	Investment	Capital	Real Depreciation	Revenue	Pre-Tax Net Income	Remaining Tax Value	Allowance	Accum. Tax Losses	Refunded Tax Losses	Value of Total Deductions	Taxable Income	Taxes	Post-Tax Cash Flow
0	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.00
1	0	1.00	0.10	0.30	0.20	1.00	0.10	0.00	0.00	0.03	0.20	0.06	0.24
2	0	0.90	0.09	0.05	-0.05	0.90	0.09	0.00	0.00	0.00	0.00	0.00	0.05
3	0	0.81	0.08	0.04	-0.04	0.81	0.08	0.05	0.00	0.00	0.00	0.00	0.04
4	0	0.73	0.07	0.04	-0.04	0.73	0.07	0.09	0.00	0.00	0.00	0.00	0.04
5	0	0.66	0.07	0.03	-0.03	0.66	0.07	0.14	0.00	0.00	0.00	0.00	0.03
6	0	0.59	0.06	0.18	0.12	0.59	0.06	0.18	0.12	0.05	0.00	0.00	0.18
7	0	0.53	0.05	0.16	0.11	0.53	0.05	0.06	0.06	0.03	0.05	0.01	0.15
8	0	0.48	0.05	0.14	0.10	0.48	0.05	0.00	0.00	0.01	0.10	0.03	0.11
9	0	0.43	0.04	0.13	0.09	0.43	0.04	0.00	0.00	0.01	0.09	0.03	0.10
10	0	0.39	0.04	0.12	0.08	0.39	0.04	0.00	0.00	0.01	0.08	0.02	0.09
11	0	0.35	0.03	0.10	0.07	0.35	0.03	0.00	0.00	0.01	0.07	0.02	0.08
12	0	0.31	0.03	0.09	0.06	0.31	0.03	0.00	0.00	0.01	0.06	0.02	0.08
13	0	0.28	0.03	0.08	0.06	0.28	0.03	0.00	0.00	0.01	0.06	0.02	0.07
14	0	0.25	0.03	0.08	0.05	0.25	0.03	0.00	0.00	0.01	0.05	0.02	0.06
15	0	0.23	0.02	0.07	0.05	0.23	0.02	0.00	0.00	0.01	0.05	0.01	0.05
16	0	0.21	0.02	0.06	0.04	0.21	0.02	0.00	0.00	0.01	0.04	0.01	0.05
17	0	0.19	0.02	0.06	0.04	0.19	0.02	0.00	0.00	0.01	0.04	0.01	0.04
18	0	0.17	0.02	0.05	0.03	0.17	0.02	0.00	0.00	0.01	0.03	0.01	0.04
19	0	0.15	0.02	0.05	0.03	0.15	0.02	0.00	0.00	0.00	0.03	0.01	0.04
20	0	0.14	0.01	0.04	0.03	0.14	0.01	0.00	0.00	0.00	0.03	0.01	0.03
NPV					0.68					0.16			0.14

B. Reinvestment Case

Appendix B shows the results for the reinvestment case. The only additional assumption which we have made for these calculations is that economic depreciation is zero. As can easily be seen from the tables in Appendix A, this assumption has the effect that the capital stock remains constant. Since the initial investment does not deplete, we need to limit the calculations of the net present values arbitrarily, i.e., to 300 periods. Throughout the entire period the firm will always make a per-period return of 30% of the initial investment, making it easier to offset accumulated tax losses and other deductions. The following three figures show the stabilisation effects for all three types of assets (which are now depreciated only for tax purposes).

Although this represents a simplified approach, because we do not model different vintages of the capital good, it is still instructive in order to illustrate the effects of carryover provisions independent of additional assumptions about economic depreciation and project lifetimes. Comparing these figures to Figures 1 to 3 in the main text shows that the results are qualitatively the same. Two additional effects drive the results in the reinvestment case. First, stabilisation values are generally somewhat lower due to the fact that shocks now have larger effects on revenues. Second, the variation around the median value of the distribution of stabilisation (and symmetry) indices decreases in line with the fact that projects are now more profitable and it is thus easier for firms to offset accumulated tax losses (and depreciation deductions) against current profits.

Figure B-1: Stabilisation Effects on Investments in Non-residential Structures (Reinvestment Case)

Figure B-2: Stabilisation Effects on Investments in Machinery and Equipment (Reinvestment Case)

Ranked by Statutory Corporate Income Tax Rates (Dark Blue)

Figure B-3: Stabilisation Effects on Investments in Intangibles (Reinvestment Case)

Ranked by Statutory Corporate Income Tax Rates (Dark Blue)

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