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Does Tax Convexity Affect Transfer Pricing Risk?

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Abstract:
Background*:We examine whether tax convexity incentives multinational firms transfer pricing risk.*
Materials and Methods*: We use an explicit measure of transfer pricing risk and regress this on three different forms of tax convexity induced by tax-law provisions, i.e., negative tax function, loss carrybacks or loss carryforwards.*
Results/Conclusion:*We find strong empirical evidence that multinational firms with negative tax functions are associated with 6.74% higher transfer pricing risk. Similarly, a year extension of loss carryforwards (carrybacks) are associated higher (lower) firms' transfer pricing risk. Alternative tests with different methodologies and estimation parameters allow us to reinforce these results.*
Key Word*:Transfer pricing; corporate taxation; tax convexity.*

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I. Introduction

In recent years, multinational firms have been under the scrutiny of important tax reforms as intragroup transactions gain relevance in global corporate taxable income or use complex pricing methods which increase firms risk exposure. One major reason concerning policyholders in international taxation relates to profit erosion (Clausing, 2009; Rego, 2010; Richardson et al. 2013; Taylor et al. 2015). Prior literature has evoked differences tax regulation related to cross-border tax rates (Devereux et al. 2008) as the critical factors behind high corporate risk (Domar and Musgrave, 1944; Smith and Stulz, 1985; Graham and Smith, 1999; and Graham and Rodgers, 2002; Guenther et al. 2017; Langenmayr and Lester, 2018; and Albertus et al. 2019). Nevertheless, it remains open for debate how tax convexity in scenarios of progressive taxation (i.e., core tax structure) or other tax code provisions (i.e., extended tax structures) incentives transfer pricing risk in multinational firms. Moreover, how to capture multinational firms transfer pricing risk profile is still unexplored and open for developments.

As identified in Graham and Smith (1999), a core tax structure relates to firms' tax functions in progressive tax systems where a unit increase in income causes an increase in tax rate, therefore, higher taxable incomes generate higher tax liabilities. On other hand, extended tax structure relates to tax preferences in code provision like, loss carrybacks or loss carryforwards periods. In either scenario's firms are exposed to tax convexity at certain extend. In the first, convex tax functions arise, most often, when (i) firms show a great variance between profits and losses, regardless of the income level, (ii) taxable income is close to zero, or (iii) taxable income show negative correlation (negative tax function). Whereas in the second scenario, loss carryforward periods or tax credits may cause the extended tax schedule to become convex, since firms reporting regular profits are less likely to have loss carryforward provisions, which implies higher expected tax liabilities. However, tax convexity in extended structures is less incisive as in core structures, as tax code provisions decrease the asymmetry on the tax treatment given to profits and losses.

Accordingly, hedging practices in firms facing some form of tax convexity, reduce volatility of taxable income and expected tax liability. In the same way, we assume that multinational firms reporting tax convexity through, either core or extended tax structures, are likely to adopt tax strategies and incur in further risk to reduce overall tax burden. A key tax strategy, very often, uses transfer pricing techniques that focus on smoothing or eroding taxable profits, regardless of the abnormal levels of risk involved in the cross border transaction. In this context, we believe that tax convexity can provide an incentive to multinational firms incur in a positive and higher transfer pricing risk.

To provide empirical evidence on these assumptions, we first developed a transfer pricing risk model with reference to country-level tax regulation, which allows to infer firms operating margin at risk if a potential transfer pricing adjustment applies. Second, we examine whether tax convexity, in different forms, incentives an increase in multinational firms transfer pricing risk profile.

We show that for every firm with negative tax function, transfer pricing risk increases (0.043), compared to firms with null or positive tax functions. Similarly, for every increase in loss carryforward periods, transfer pricing risk increases (0.043), while for every increase in carryback periods, transfer pricing risk decreases (-0.051). The positive and larger effects from loss carryforwards predicts the forward looking strategy of transfer pricing in "hedging" uncertainty regarding future taxable income.

This paper introduces relevant contributions to existing literature by showing why multinational firms engage in higher levels of transfer pricing risk. Thus, we first model an explicit and distinct measure of transfer pricing risk that prior literature (John et al. 2008; Guenther et al. 2017; Albertus et al. 2019; or Hutchens et al. 2019) commonly measures from a general corporate risk perspective (i.e., standard deviation of adjusted ROA, volatility of cash flows, or effective tax rates). Moreover, our model takes account on the properties of Scholes Wolfson framework by adopting a multilateral method and considering all forms of taxes, as transaction costs involved. In fact, this model expects to enhance future research replicating transfer pricing risk across various industries and countries tax legislation. Second, at the best of our knowledge, this paper makes the first empirical contributions on how an explicit function of transfer pricing risk responds to core and extended tax properties as studied in Smith and Stulz (1985), Nance et al. (1993), Graham and Smith (2002), and Graham and Rogers (2002). Particularly, we show that transfer pricing strategies may provide firms with a valid instrument to reduce uncertainty in taxable income. Third, we extend remarkable contributions of prior research on corporate tax risk (Sandmo, 1971; Keen and Konrad, 2013; Khanna and Yafeh, 2005; Guenther et al. 2017; and Langenmayr and Lester, 2018) by showing that prior conclusions in these studies may change in the context of transfer pricing. Finally, this study also informs policyholders and governments about the need for harmonization in international taxation. Specifically, we show how entangled domestic tax law and transfer pricing principles encourage multinational firms to increase their transfer pricing risk profile. Despite the achievements of BEPS (2015) and other recent transfer pricing guidance (i.e., on financial transactions or digital taxation) cross-country consensus between domestic corporate tax law and transfer pricing rules (i.e., exploitation of intangibles, and risky transactions) lacks improvement and coordination.

This paper encourages governments and policyholders for "friendly" but "effective" tax policies, rather than harmful competition between OECD countries and low-tax jurisdictions (Becker and Fuest, 2012). The remain of the paper is structured as follows: section 2 provides an overview in prior literature on transfer pricing and corporate tax risk; section 3 presents relevant theory and formalized the hypotheses; section 4 describes the sample structure and research design; section 5 presents the results and formulates alternative tests; and, section 6 concludes.

II. Literature review

Transfer pricing

Transfer pricing at the center of this paper relates to prior literature on risk management, tax risk or transfer pricing aggressiveness. For instance, Klassen and Mescall (2018), applied a survey test to world transfer pricing experts, and developed a transfer pricing risk measure that previews the study of transfer pricing enforcement in the context of cross border mergers and acquisitions. In the same spirit, Borkowski and Gaffney (2014), conducted a survey to tax authorities in PATA (Pacific Association of Tax Administrators) countries and transfer pricing experts to assess firms transfer pricing exposure. On the other hand, Richardson et al. (2013) and Taylor et al. (2015) developed a sum-score approach of categorical variables based on the Internal Revenue Service (IRS) transfer pricing audits, to measure the effects of (i) size, leverage, profitability, intangibles, multinational and tax havens, and (ii) multinationality, intangibles, and tax havens, respectively, on transfer pricing aggressiveness.

Corporate tax risk

On the other strand of the literature, we have a pioneering research of Neuman et al. (2019) that developed a corporate tax risk measure considering three main sources of tax risk, that is, economic risk, uncertainty in tax law systems, and lack of reliable information. In fact, the whole rationale is in line with Fris et al. (2014), that require an effective application of the arms' length principle to be aligned with multinational firm's value maximization. However, a pioneer research on the impact of taxes on investment decisions and corporate risk, started with Domar and Musgrave (1944), whom examined how tax rates imposed by tax authorities on investor's wealth (private and corporate) would affect the level of risk-taking on investment decisions. Further, Feldstein (1969) demonstrated in a very weak form that proportional taxation does not cause, necessarily, investors to maximize risk-taking for higher yields. In a more strategic field of risk and tax policies, Smith and Stulz (1985), Nance et al. (1993), Graham and Smith (1999) studied how hedging practices reduce uncertainty on future tax liabilities in firms facing convex tax functions. Additionally, the authors examined how this strategic uncertainty would interact with various tax law provisions like progressive statutory

tax rates or tax-loss treatments. More recently, Guenther et al. (2017) presented empirical results on how different strategies to reduce tax burden and greater corporate risk could be associated.

Finally, Langenmayr and Lester (2018) have added important theoretical and empirical contributions regarding corporate loss rules and risk, by showing how tax loss offsets determine the corporate level of risk-taking. In summary, prior literature have made clear to governments, policyholders, investors, practitioners, and research community about the importance of how transfer pricing and corporate tax risk affects innovation, investment, and economic growth. However, how different sources of tax convexity encourage multinational firms to induce or reduce transfer pricing risk remains imperceptible and open for debate in the context of the above mentioned literature.

III. Theory and hypothesis development

The association between tax convexity and transfer pricing risk in core tax structures

According to Tax incentives to hedge convex tax functions was first introduced by Smith and Stulz (1985) that argued to low variability in pre-tax earnings to generate a reduction in expected corporate tax liability. One main source of a convex tax function is given by firms' reporting a negative serial correlated income (EBIT, for instance). In other words, properties as such means that firm's income becomes uncertain with frequent changes between profit and losses. Such events in progressive tax systems, with non-linear marginal tax rates, make firms to become more sensitive to tax liabilities (Graham and Smith, 1999). However, this exposure can be managed if firms employ transfer pricing strategies that smooth income. Some of these techniques carry a certain degree of risk that is not always consistent with arm's length principle. In this context, our intuition is that multinational firms facing negative tax functions, as a proxy of tax convexity, are likely to show a positive association with transfer pricing risk. This reasoning drives us to the following hypothesis:
H1. Negative tax functions are positively associated with transfer pricing risk.

The association between tax convexity and transfer pricing risk in extended tax structures

Firms net operating losses can be recovered in vast majority of tax laws through provisions that allow firms to use prior or future tax expenses to offset current losses. These provisions allow firms to properly manage their losses, where loss carrybacks being preferred to loss carryforwards, most often. For instance, Langenmayr and Lester (2018) show theoretically and empirically that loss carryback periods have a positive and greater effect on corporate risk-taking as firms are allowed for an immediate tax refund from prior year's tax paid. The authors conclusions stand from a general corporate risk taking and investment perspective. Conversely, from a transfer pricing risk strategy, overall reasoning may differ. For instance, Graham and Smith (1999) show that firms with current net operating losses have less incentives to hedge when future losses are expected since hedging not only reduces the "curvature" of a convex tax function, but also the likelihood of the firm to use such losses. Analogously, firms expecting to be profitable do have the incentive to hedge. In this context, we assume transfer pricing risk follows a forward-looking perspective with overall purpose of smooth and structure present or future taxable income rather than take a risky approach to benefit from prior tax refunds. For these reasons, we expect firms transfer pricing risk to have a positive association with the increase in loss carryforward periods. This drives us to the following hypothesis:
H2. The increase in loss carryfoward periods is positively associated with transfer pricing risk.

Further, Graham and Smith (1999) document that firms with net operating losses and significant amount of prior tax paid would experience different tax rates on a potential refund which generates "non-convex regions" in each year refund, and therefore reduce the incentives for hedging. In this context and given previous assumption that transfer pricing strategies are forward looking based, we expect the increase in loss carryback periods to have a negative association with transfer pricing risk. To examine this association, we formulate the following hypothesis:
H3. The increase in loss carryback periods is negatively associated with transfer pricing risk.

IV. Research design

Data source and sample selection

Our sample comprises a set of parent multinational firms located in the OECD political region owning at least one worldwide foreign affiliated, for the period comprehended between 2010 and 2018. Given the particularities of a transfer pricing analysis, ownership requirements were assessed with greater detail from Orbis database (Bureau Van Dijk). The selected multinational firms (i) are the global ultimate owner of the foreign subsidiary , and (ii) own a direct or total percentage in its foreign subsidiary of at least 25%.

Unknown shareholders locations (i.e., "n.a.") were excluded. Financial information is at the unconsolidated level. From an average initial sample of 61915 firm year, we eliminate firms missing industry identification (Nace rev.2; 2775 firm year), as financial and insurance firms (11326 firm-year) given the particularities of transfer pricing and risk in these industries. Additionally, we exclude firms missing full ten-

year period information (34123 firm-year). Finally, we drop firms missing corresponding data to dependent variable (7502 firm-year), arriving to a final set of 6189 firm-year.

The selected dataset considers a period with relevant alterations in transfer pricing regulation concerning the introduction of business restructuring section (chapter X) to "guidelines" in 2010 , and BEPS (2015) actions 8-10 focused in three main areas, (i) transactions involving intangibles, (ii), contractual allocations of risk, and (iii) profit allocation with no economic rationale. Complementary, our dataset is built on harmonized regulation, with countries following OECD transfer pricing guidelines, like other prior research approach using identical geographical areas (Devereux et al. 2002).

Dependent variable

As previously described, we show how transfer pricing strategies allow multinational firms to reduce overall tax liability. Despite the remarkable advances in transfer pricing law, multinational firms still find advantageous to take arbitrage positions on intragroup transactions, even despite the risk of tax authorities challenge intragroup terms and conditions.

In this context, intra-group transactions must be priced at arm's length conditions or have a reasonable economic judgment behind its price or profit determination. If not, local tax authorities in the scope of their innovation and strength, will reassess the price or profits and determine the upward adjustment on tax liability. In this context, we measure transfer pricing risk (TP_Risk) by identifying each firm operating margin (OM) at risk due to transfer pricing. Since the fraction of the global OM resulting from intragroup transactions is unknown, we use the difference between the industry-year OM and each firm OM to capture any variation falling outside of arm's length range. Thus, the differential is assumed to arise out of transfer pricing strategies. Accordingly, each firm transfer pricing risk is given as: the product of the operating margin at risk (OMR) likely to be challenged by tax authority's give a certain probability, Pd (A).

$$TP\_Risk = OMRx\ Pd\ (A) \quad (1)$$

The probability of an audit is exogenous and increases according to each country fiscal strength rule index (FSRI) profile, as developed in Deroose et al. 2006. The OMR is a function of (i) operating margin difference (OMD), which can be strategic or not strategic, (ii) the number of foreign affiliates located in low tax rates jurisdictions, compared to domestic parent tax rate, (iii) the statutory tax rate, and (iv) a penalty applicable on the operating margin adjustment. The magnitude of the OMD and the number of foreign affiliates in low tax jurisdictions are critical when determining the transfer pricing risk. Similarly, the penalty applicable is also likely to have a considerable impact. In this respect, we use 2017/2018 as a reference period to obtain the penalties information in each country from Ernst Young transfer pricing guide. For example, in Belgium, penalties vary between 10% and 200% depending on the intention and negligence of the taxpayer.

The strategic OMD arises when firms operating margin is below the arm's length range . On the other hand, non-strategic OMD arises when firms operating margin are within the arm's length range, but the tax authorities may have a different interpretation of what the correct OM would be, regardless of firms true and fair OM estimate. In the sense that tax authorities do not differentiate between what is strategic and non-strategic, we assume the non-strategic OMD to be exposed to same penalties and tax enforcement treatments. To illustrate how to arrive at the transfer pricing risk variable, we formulate the following equations:

$$OMR = ((OMD*F)*t)+p \quad (2)$$

where,

$$OMD = S \text{ or } NS, \quad (3)$$

$$S = Strategic\ if\ [OM1Q - OM, 0]; \quad (4)$$

$$NS = Non\text{-}Strategic\ if\ [OM - OM3Q, 0] \quad (5)$$

OMD stands for the operating margin difference; F is the number of foreign affiliates located in low tax rates jurisdictions, compared to domestic parent tax rate; t represents the corporate tax rate; p relates to the penalty, at country level, on the operating margin adjustment; S refers to the strategic operating margin deviating from the arm's length range; NS identifies the non-strategic operating margin; OP1Q: first quartile of an arm's length range. Signals the minimum operational margin accepted by tax authority's; OP3Q is the third quartile of an arm's length range. Signals the maximum operational margin accepted by local tax authority; OM identifies each firm's operational margin.

Independent variables

Negative tax function: According to Graham and Smith (1999) tax functions (i) close to zero, (ii) with greater volatility, or (iii) showing a negative serial correlation, increase firms' incentives to use hedging instruments. Regardless of the earning levels (i.e., turnover, EBITDA, or EBIT), authors had shown that hedging incentives does not differ substantially. For instance, in further research Graham and Rodgers (1999) applied two different measures (sales revenue and profit before tax) with qualitative results remaining consistent. In this context, our measure of convexity in core tax structures, is given by the negative tax function (NTF) variable that takes the serial correlation coefficient from each firm turnover (2010 2018). To accurately capture for the convexity effects of NTF, we then converted into a dummy variable of 1 those coefficients showing a negative value, 0 otherwise.

Loss carryback and loss carryforward provisions: Tax loss carryback (LCB) and loss carryforward (LCF) variables in this paper are directly related to each country tax law on loss provisions. In line with Graham and Kim (2009) and Langenmayr and Lester (2018), our rationale for carryback and carryforward measurement is based on governments decision power to change such provisions, with the effect of those changes having a significant and direct impact on firms tax risk. We measure LCB and LCF provisions as the length of statutory number of years in which operating losses can be used.

Control variables: Our study is represented by control variables like intangibles intensity (Intangibles), stock intensity (Stock), firm dimension (Size), firm financing options (Gear), return on equity (ROE), and consumer price index (CPI). Intangibles represents a key risk factor in transfer pricing transactions. For example, German tax authorities, despite the robustness of economic analysis and effective documentation, very often challenge intragroup transactions involving intellectual property, classifying them as high risky (EY, 2018). Stock intensity captures the extend which inventory substitutes capital intensity. High intense inventory firms are likely to report higher effective tax rates, which infers lower risk taken in planning transfer pricing strategies. (Zimmerman, 1983; Richardson and Lanis, 2007). Size controls the complexity and risk that larger firms present in related business activities and fragmented business models, contrarily to smaller firms. Rego (2010) identified larger firms to be more competitive, once present greater resources and lower tax planning costs compared to smaller firms. Additionally, Dyreng et al. (2009) found larger firms to report greater tax discrepancies on its effective tax liability. Gear controls firms reporting high debt levels, which according to Dyreng et al. (2008) consubstantiates the most preferential form of financing for firms operating in jurisdictions with high statutory tax rates. At this level, multinationals tend to present greater risk profile, as intragroup debt policies take arbitrage opportunities to report high tax deductions in advantageous tax jurisdictions. Lately, ROE looks after profitable firms planning for mispricing intragroup transactions by increasing (decrease) profits in low (higher) tax jurisdictions. CPI measures for consumer index prices trends likely to affect the relation between tax convexity and negative tax function on transfer pricing risk. Control variables are all winsorized at the firstand last percentile, with the exception of CPI.

Regression models

We test the association of negative tax functions, loss carrybacks and loss carryforwards, on transfer pricing risk by employing the following model:

$$TP\_Risk_{it} = \alpha_0 + \beta_1.NTF_i + \beta_2.LCB_{ic} + \beta_3.LCF_{ic} + \beta_n.X_i + \varepsilon_{it} \quad (6)$$

TP_Risk stands for the transfer pricing risk in firm i; NTF is a dummy variable that equals 1 if firm i shows a negative serial correlated turnover, 0 otherwise; LCB is the statutory number of years allowed in country c which operating losses can be carried back; similarly, LCF is the statutory number of years allowed in country c which operating losses can be carried forward; X relates to a set of control variables, as discussed before; ε, identifies the error term.

V. Empirical results

Descriptive statistics

Table 1 (Panel A) presents the descriptive statistics of the main variables in this study. Specifically, TP_Risk shows sample firms to score an average of 0.638 transfer pricing risk profile with a variation between the 5th and 95th percentile of -0.223 to 1.295, respectively (i.e., since upper limit is far distant from 0, it suggests that greater fraction of sample firms faces medium/high transfer pricing risk). On other hand, NTF indicates that sample firms show on average a positive serial correlated tax function of approximately 0.100. The median loss carryforward period for sample firms is 17 years, whereas carryback periods shows a zero median. Table 1 (Panel B) shows the sample observation distribution across OECD countries, the average statutory tax rate (2010-2018) for domestic firms, and the median the loss carryforward and carryback periods. Countries observations are reasonable distributed, exception made to greater economies, such as, Italy, France,

and Spain. On the other hand, countries average statutory tax rate (2010-2018) is about 24.61%, with France and Belgium registering the highest rates, 36.83% and 33.99%, respectively.

Table no 1:Panel A -Descriptive statistics.

Multinationals	n	Mean	Median	Std. Dev.	5% Perc.	95% Perc.
TP_Risk	61 890	0.638	0.620	0.502	-0.223	1.295
NTF	61 890	0.100	0	0.300	0	1
LCF	61 890	15	17	5	5	17
LCB	61 890	0	0	0	0	1
Intangible	61 890	0.027	0.005	0.061	0.000	0.138
Stock	61 890	0.159	0.131	0.150	0.000	0.447
Size	61 890	4.026	4.039	0.719	2.804	5.210
Gear	61 890	0.818	0.451	0.973	0.005	2.893
ROE	61 890	0.132	0.103	0.174	-0.073	0.438
CPI	61 890	1.407	1.235	0.416	1.119	2.111

Table no 1:Panel B -Descriptive statistics.

	Multinational		Combined Statutory Tax Rate 2010-2018	LCF	LCB
Country	#obs	%	Average (%)	N.º Years	
Austria	14	0.23	25.00	17	0
Belgium	425	6.87	33.99	17	0
Czech Republic	338	5.46	19.30	5	0
Estonia	28	0.45	20.70	17	1
Finland	46	0.74	23.30	10	0
France	811	13.10	36.83	17	1
Germany	32	0.52	29.62	17	1
Greece	31	0.50	25.30	5	0
Hungary	152	2.46	18.20	5	0
Ireland	12	0.19	12.50	17	1
Italy	2109	34.08	30.99	17	0
Luxembourg	17	0.27	28.84	17	0
Netherlands	5	0.08	25.15	6	1
Norway	118	1.91	27.10	17	0
Poland	22	0.36	19.00	5	0
Portugal	363	5.87	29.10	5	0
Slovakia	279	4.51	20.50	4	0
Slovenia	76	1.23	18.80	17	0
Spain	843	13.62	28.80	17	0
Sweden	166	2.68	24.32	17	0
Turkey	6	0.10	20.00	5	0
United Kingdom	296	4.78	24.00	17	1

Regression results

Table 2 presents the OLS coefficients determining the association between of transfer pricing risk and core/extended tax structures. Column (1) shows for the average firm in our sample that NTF is associated with 6.74% higher transfer pricing risk (coefficient: 0.043). Thus, H1 is supported: negative tax functions are positively associated with transfer pricing risk. Similarly, column (2) suggests for the average firm that one tax period loss carryforward extension is positively and significantly associated with higher transfer pricing risk. In this context, H2 is supported: the increase in loss carryforward periods is positively associated with transfer pricing risk. On the other hand, column (3) shows that for the average sample firm, one tax period carryback extension is associated with 7.99% lower transfer pricing risk (coefficient: -0.051). This supports H3: the increase in loss carryback periods is positively associated with transfer pricing risk.

To examine for consistency, column (4) takes all explanatory variables into equation. Overall, the results remain in line with prior findings.

Table no 2: Association between transfer pricing risk and core/extended tax structures.

Variables	Dependent variable: TP_Risk			
	(1)	(2)	(3)	(4)
NTF	0.043**			0.048***
	(0.019)			(0.017)
LCF		0.043***		0.048***
		(0.001)		(0.001)
LCB			-0.051***	-0.180***
			(0.013)	(0.012)
Intangible	0.260***	-0.004	0.316***	0.175**
	(0.093)	(0.084)	(0.094)	(0.083)
Stock	-0.207***	-0.134***	-0.211***	-0.143***
	(0.038)	(0.035)	(0.038)	(0.034)
Size	-0.023***	-0.084***	-0.019**	-0.075***

	(0.008)	(0.007)	(0.008)	(0.007)
Gear	0.101***	0.082***	0.098***	0.069***
	(0.006)	(0.005)	(0.006)	(0.005)
ROE	-0.090***	-0.112***	-0.082**	-0.069**
	(0.033)	(0.030)	(0.033)	(0.029)
CPI	-0.494***	-0.359***	-0.488***	-0.326***
	(0.014)	(0.013)	(0.014)	(0.013)
Constant	1.375***	0.826***	1.368***	0.708***
	(0.038)	(0.037)	(0.038)	(0.037)
Control-effects	Yes	Yes	Yes	Yes
Industry-effects	Yes	Yes	Yes	Yes
p-value	[0.000]	[0.000]	[0.000]	[0.000]
Adjusted R^2	0.229	0.371	0.231	0.395
N	61 890	61 890	61 890	61 890

Table 2 uses an OLS regression to examine the assocation of negative tax functions and loss offset rules on firms transfer pricing risk. Columns (1) to (3) report the regression coefficients for core and extended tax structures variables, respectively. Column (4) presents the results from a regression including all main explanatory variables. Each regression estimate takes control-effects and industry fixed-effects. We present the model *p-value* in square brackets.

***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1 level, respectively.

We present coefficient estimates *with standard error* in parentheses. Variables definition are presented in detail in table (1).

Alternative tests

We extend our understanding about transfer pricing risk by examining its responsiveness in a context of investments with risky intangibles. Prior literature identified that difficulties in benchmarking "hard to-value" intangibles provide managerial agents the opportunity to explore tax benefits from IP regimes , which are taxed at very low rates on income arising from the transferred intangible (Shackelford et al. 2011). Accordingly, we study whether risky intangibles promote transfer pricing risk in firms facing high and low tax asymmetry. The riskiness of intangibles (INT_Risk) assumes that firms with R&D projects showing low capitalization and greater volatility are most likely to shift projects to foreign affiliates at an initial stage, which justifies a low-valuation price upon the sale. For instance, Oswald (2008) showed that loss making firms are more propense to capitalize R&D expenditures, as so do firms with high earnings volatility. In this context, we measure INT_Risk by taking the coefficient of variation of intangibles for the period of 2010-2018.

This approach extends our knowledge from previous hypotheses, by assuming that multinational firms with long-run tendency for low and volatile R&D capitalization are more propense to engage in higher transfer pricing risk profile, mainly if (i) exposed to high tax asymmetry (TaxAsymm), measured as the difference between the average (2010-2018) statutory corporate tax rate of a parent firm and its foreign affiliates, or (ii) if foreign affiliates are located in advantageous IP regimes. We formally investigate for these assumptions by developing further hypotheses:

H4. The effect of risky intangibles on transfer pricing risk is greater in firm's with high tax asymmetry.

H5. The effect of risky intangibles on transfer pricing risk is greater in parent firm's with foreign affiliates located in IP regimes.

Table 3 shows the coefficients results from an OLS regression for risky intangibles effects on transfer pricing risk profile. Columns (1) and (2) show for every one percent increase in intangibles riskiness, transfer pricing risk increases 0.064 in firms with higher tax asymmetry, and decreases 0.051 in firms with low tax asymmetry, respectively. This supports H4. Similarly, columns (3) and (4) shows that for every one percent increase in intangibles riskiness, transfer pricing risk increases 0.227 for firms located in IP-regimes, and decreases 0.051 in firms in non-IP regimes, respectively. However, the coefficient in non-IP regime show no statistical significance, so we could not validate H5.

Table no 3: Alternative analysis: association between risky intangibles and transfer pricing risk.

Variables	Dependent variable: TP_Risk			
	(1) High Asymmetry	(2) LowAsymmetry	(3)	(4)
	0.064***	-0.051**	0.227*	-0.051
INT_Risk	(0.024)	(0.028)	(0.116)	(0.072)
	[10.03%]	[-7.99%]	[35.58%]	[7.99%]
Stock	-0.212**	0.020	-0.529	-0.651**
	(0.087)	(0.106)	(0.327)	(0.305)
Size	-0.136***	-0.094***	-0.070	-0.191***
	(0.019)	(0.025)	(0.091)	(0.062)
Gear	0.088***	0.125***	0.064	0.098
	(0.011)	(0.015)	(0.065)	(0.065)
ROE	-0.137*	-0.215**	0.309	-0.163
	(0.074)	(0.090)	(0.315)	(0.194)
CPI	-0.748***	-0.280***	-1.069***	0.390***
	(0.051)	(0.026)	(0.189)	(0.079)
Constant	2.339***	1.365***	2.315***	2.031***

	(0.097)	(0.116)	(0.411)	(0.342)
Industry-effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.307	0.211	0.338	0.369
N	9340	9730	750	750

Table 3 shows transfer pricing risk association to risky intangibles in firms with negative tax functions, facing tax asymmetry, and with subsidiaries located in IP regimes. Column (1) and (2) identify those firms at the 75th and 25th quartile of tax asymmetry. Column (3) uses a set of firms with negative tax function, facing tax asymmetry, and with subsidiaries located in IP regimes. Column (4) shows firms with opposite status, as column (3).
***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1 level, respectively.
We present coefficient estimates with *standard error* in parentheses. We show in squared brackets the economic significance effects from *INT_Risk* on *TP_Risk.*
Variables definition are presented in detail in appendix (A).

In table 4, we disclose the results for additional robustness tests by considering alternative risk measures from existing literature. We use a logistic regression model to infer about the transfer pricing risk likelihood association with explanatory variables. In columns (1) to (7) we use a dummy variable to capture about the average difference between firm's ROA and industry-year ROA: it equals 1 if firm's Risk_ROA is below the industry-year average, 0 otherwise. Results show coefficients to remain consistent, suggesting a positive and significant association between Risk_ROA, NTF, TaxAsymm, and interaction terms, NTF*TaxAsymm, and LCF*TaxAsymm. On other hand, results for LCB and LCB*TaxAsymm remain negative. Similarly, LCF is positive associated with firm risk, however it shows no significance. In same spirit, columns (8) to (14) use Risk_CashFlow to capture cash flow riskiness given industry-year deviations. Overall, results are consistent with those obtained from table 2 and 3.

Table no 4: Alternative analysis.

	Dependent variables													
Variables	*Risk_ROA*								*Risk_Cash Flow*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
NTF	0.282***							0.285***						
	(9.212)							(8.887)						
LCF		0.003							0.017***					
		(0.291)							(6.617)					
LCB			-0.254***							-0.084				
			(16.560)							(1.536)				
TaxAsymm				1.431***							0.818**			
				(14.445)							(4.484)			
*NTF*TaxAsymm*					1.920*							1.154		
					(2.183)							(1.014)		
*LCF*TaxAsymm*						0.079***							0.047**	
						(11.752)							(4.015)	
*LCB*TaxAsymm*							-0.685							-0.920
							(1.306)							(2.005)
Constant	0.237	0.232	0.199	0.159	0.255	0.171	0.309	-0.209	-0.408**	-0.191	-0234	-0.178	-0.230	-0.123
	(1.492)	(1.198)	(1.054)	(0.661)	(1.734)	(0.772)	(2.507)	(1.005)	(3.186)	(0.828)	(1.228)	(0.729)	(1.194)	(0.340)
Controls variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Pseudo R^2	0.189	0.188	0.191	0.190	0.188	0.190	0.188	0.162	0.161	0.160	0.161	0.160	0.161	0.160
N	61650	61 650	61 650	61 650	61 650	61 650	61 650	57070	57 070	57 070	57 070	57 070	57 070	57 070

Table 4 shows alternative tests to main hypothesis. Columns (1) to (14) follow the rational from tables 3 and 4, but apply a logistic regression, as alternative measures of firms risk-taking used in prior literature (John et al. 2008; Langenmayr and Lester, 2018; Albertus et al. 2019). Columns (1) to (7) uses a ROA risk measure adjusted to industry-year average. Columns (8) to (12) follows identical rationale, but instead uses the cash-flow risk. Control variables are included as in tables 3 and 4, exception made to ROE to prevent multicollinearity problems and regression coefficients bias. We present the model *p-value* in square brackets.
***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1 level, respectively.
We present logistic coefficient estimates with *Wald* X^2 in parentheses.
Variables definition are presented in detail in appendix (A).

VI. Conclusion

In this paper we examine how tax convexity in scenarios of progressive taxation (i.e., core tax structure) or other tax code provisions (i.e., extended tax structures) incentives transfer pricing risk in multinational firms. We use a sample of parent firms located across the OECD political region between 2010-2018. We show that convexity through negative tax functions (NTF) or the increase in loss carryforwards periods (LCF) to be positively associated with transfer pricing risk. On other hand, the increase in loss carryback periods (LCB) is negatively associated with transfer pricing risk. A possible reason for this outcome is provided by Graham and Smith (1999) that show "non convex regions" often present in extended tax structures to encourage a reduction in hedging or other practices aiming to smooth taxable income.

Additionally, we study the effects of risky intangibles on transfer pricing risk. Empirical findings suggest that transfer pricing is more responsive to risky intangibles in firms with high tax asymmetry, compared to those with low tax asymmetry. Similarly, we found this behaviour to be consistent in firms located in IP regimes.

Our study provides strong empirical evidence for policyholders (such as, OECD, UN, and local governments) that want to regulate and reduce firm's propensity to explore transfer pricing risk strategies or transfer pricing rules misalignment. The findings resulting from this paper could possibly be monitored by corporate governance mechanisms (Klassen and Laplante, 2012; Guenther et al. 2017; Langenmayr and Lester, 2018; Albertus et al. 2019). In this respect, despite the recommend changes to OECD tax systems and transfer pricing legislation, firms' risk governance guidelines and procedures should also help in reducing transfer pricing risk. Therefore, we foresee the study how corporate governance at the country and corporate level affects transfer pricing risk an interesting avenue for research.

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Appendix

Variable Definitions

Variables	Description	Source
	Country-Level	
LCF	Median statutory number of years which operating losses can be carried forward with reference to country-tax law (2010-2018).	PWC; EY
LCB	Median statutory number of years which operating losses can be carried back, with reference to 2019 country-tax law (2010-2018).	
CPI	Consumer price Index *per* country weights in percentage of OECD Total.	OECD
Firm-Level		
TP_Risk	TP_Risk = OMR*Pd (A) where: OMR = ((OMD*F)*t) + p, and, OMD = S or NS — Strategic *if* $[OM_{1Q} - OM_F, 0]$; Non-Strategic *if* $[OM_F - OM^{3Q}, 0]$ where: TP_Risk: transfer pricing coefficient at risk. OPM: operating Margin at risk. Pr (A): probability of transfer pricing audit according to each country fiscal strength rule index (FSRI) profile. S: number of foreign subsidiaries in countries with lower corporate tax rates. *t*: corporate tax rate. *p:* penalty, at country level, for transfer pricing adjustment. ALD: arm´s length difference. M: mispricing fraction of arm's length difference. NM: not mispricing fraction of arm's length difference. OP_{1Q}: first quartile of an arm's length range. Signals the minimum operational margin accepted by local tax authority. OP_{3Q}: third quartile of an arm's length range. Signals the maximum operational margin accepted by local tax authority. OP_F: firm's operational margin.	
NTF	1 if ten-year (2010-2018) turnover serial correlation for *firmf* is negative, 0 otherwise.	Graham and Smith (2002)
Control variables		
Intangibles	Ratio of intangibles to total assets.	Orbis

Stock	Ratio of stock to total assets.	Orbis
Size	Logarithm of total assets.	Orbis
Gear	Ratio of Non-Current Liabilities plus Loans divided by Shareholders Funds.	Orbis
ROE	Ratio of net income to shareholder's equity	Orbis

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