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Risk is Risk?

Alex Stomper
Humboldt University

Marie-Louise Vierø
Queen's University

Department of Economics
Queen's University
94 University Avenue
Kingston, Ontario, Canada
K7L 3N6

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Alex Stomper*　　Marie-Louise Vierø
Humboldt University　　Queen's University

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Abstract

We analyze the relation between firms' exposure to exogenous business risk and their financing choices, based on a sample of firms for which we can measure such exposure. The results show that firms more exposed to exogenous risk use less debt financing. We also analyze the relation between the volatility of the firms' returns-on-assets, and their use of debt financing. The result is the opposite of that obtained for exogenous risk: we find a positive relationship between debt financing and the risk of firms. Overall, our results show that different types of risk are associated with different financing choices. While exogenous risk causes firms to use less debt financing, debt financing causes firms to take risk endogenously. This result explains contradictory findings regarding the relation between risk and debt financing in the prior literature.

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"risk is a risk is a risk."

Getrude Stein, 1922, "Geography and Plays".

1 Introduction

The relation between risk and firms' financing choices has become a key issue ever since Jensen and Meckling (1976) pointed out that debt financing can create incentives for firms' junior claimants to pursue, or at least accept, policies that increase the risk associated with the firms' operations.[1] The issue is not an "academic" one, but is regularly mentioned in discussions about ex-ante effects of economic policies that effectively limit the liability of firms' junior claimholders for their firms' obligations to senior creditors. Discussions about deposit insurance and public bailouts of banks are a case in point, but risk-taking incentives associated with debt financing are also relevant outside the financial industry. For example, an oil company may decide to risk an oil spill since the cost of cleaning-up would put the company into bankruptcy, and would thus be borne mostly by the firm's creditors.

While the effect of debt financing on risk taking has been extensively analyzed both theoretically and empirically, the effect of risk on financing choices has received less attention, but is no less relevant since there may exist a feedback effect: risk may cause firms taking on debt, and the debt may cause firms taking more risk. From a theoretical perspective, the first effect could exist for a number of reasons. For example, the effect may be a consequence of firms' owners wanting to reduce their equity investments into the firms when the riskiness of the returns increases, and the equity getting substituted by debt; Chen, Miao and Wang (2010) provide an analysis. However, it is also possible to argue against the effect. A traditional argument is based on the trade-off theory of debt financing which traditionally emphasizes trade-offs between tax-savings associated with the tax-deductibility of interest, and bankruptcy costs.

[1] See Ross (2004) for a general analysis.

According to these arguments, a lower degree of leverage may be optimal for a firm more exposed to exogenous risk in order to avoid bankruptcy costs.

In this paper, we seek to clarify the relation between risk and debt financing on empirical grounds, based on data about a sample of firms for which we can observe exposure to exogenous risk. The firms are hotel businesses in Austrian ski resorts that are exposed to weather risk due to weather-induced demand shocks: demand drops if there is no snow. The risk differs across regions due to differences in location and altitude. Furthermore, hotels in different regions are exposed to this risk to different extents, for example due to the presence of equipment to generate artificial snow. This motivates computing a measure of aggregate volume flexibility for each region to determine regional weather exposure.

We measure aggregate volume flexibility based on data about the aggregate number of (international as well as Austrian) tourists that arrived at hotels in different skiing areas ("regions"). We regress these regional arrival numbers on weather realizations, and use the regression coefficients as measures of regional weather exposure. In our subsequent firm-level analysis, these measures are used to control for differences in aggregate volume flexibility across regions, as well as for other determinants of weather exposure.

We next move to the level of individual firms in our sample. The firm-level analysis has two parts. We first estimate causal effects of risk on firm financing, and then analyze causal effects of debt financing on firms' risk taking. We can distinguish between exogenous risk defined at the regional level, and firm-level risk. Exogenous risk is weather risk, measured in terms of the volatility of past weather realizations, and regional weather exposure. Firm-level risk is measured in terms of the volatility of firms' returns-on-assets and depends on the firms' endogenous operating policies. GMM estimates show that firm-level risk has a positive effect on firms' use of debt financing, but exogenous risk has a negative effect. The first effect confirms a finding of MacKay and Phillips (2005) in an econometric framework that inspires our analysis, but

MacKay and Phillips cannot distinguish between different types of risk. By drawing such a distinction, we contribute to the literature on capital structure choice, where different papers have found contradictory results regarding the relation between firm-level risk and financing.[2] Our findings suggest that these contradictions resulted from a failure to distinguish between exogenous and endogenous risk: risk is not simply risk.

The paper is structured as follows: Section 2 discusses existing empirical evidence. Section 3 presents the main analysis, and Section 4 concludes.

2 Existing empirical evidence

Before we turn to our own analysis, we here discuss some existing empirical evidence. In the literature on capital structure choice, different papers have found contradictory results regarding the relation between firm-level risk and financing. Kim and Sorensen (1986) find a positive relation between leverage and cash-flow volatility, Bradley, Jarrell and Kim (1984) find a negative relation, and Titman and Wessels (1988) find no significant relation. Levine and Wu (2017) use the diversifying effect of mergers to identify changes in risk exposure for a cross section of firms and find a negative relationship between firm risk and leverage.

MacKay and Phillips (2005) (hereafter: MP) conduct an analysis of firms' financial and operating policy choices in a large number of different industries. Their analysis features three dependent variables: the financial leverage, capital intensity, and riskiness of firms, where riskiness is measured in terms of the volatility of firms' operating profits. MP finds positive correlations between the three dependent variables.[3]

MP also use GMM in order to estimate causal effects, but they make no attempt to identify effects of exogenous risk on firms' financing choices. Our

[2] See Section 2.

[3] See Table 5 of MacKay and Phillips (2005).

empirical analysis complements their analysis. Rather than analyzing data about firms in a large cross-section of different industries, we focus on one industry in which firms operate in segmented regional markets, face similar financial and operating policy options, and are subject to similar exogenous risk factors. We will view different regions as different industries, and we will correspondingly use the term “industry” from now on. By analyzing data about rather similar “industries”, we can measure effects of industry-level differences in exogenous risk on the extent to which firms use debt financing. Moreover, we can define measures of aggregate volume flexibility in order to control for the effect of industry structure on the extent to which individual firms are exposed to exogenous risk.

3 Empirical analysis

3.1 The data

Our empirical analysis will be based on data about a large number of firms that are all family-owned hotel businesses accommodating (international and Austrian) tourists visiting Austrian ski resorts. This sample is ideally suited for an analysis of effects of exogenous risk on firms’ financing since the firms are all exposed to demand risk induced by weather risk. The risk mostly concerns the demand during the weeks at the start and the end of the skiing season, i.e. weeks in December and March. For example, it may turn out in March that there will not be enough snow for skiing during the Easter holidays at the end of March. If so, hotels in affected ski resorts can respond to the imminent demand shock like the firms in our model: by closing down before the Easter holidays. In December, the hotels can respond to a lack of snow in ski resorts by postponing their opening for business.

Our data about the firms has been provided to us by the Austrian Hotel- and Tourism bank (AHTB) and includes standard balance sheet and P&L accounting data. We will use the data in order to define two different measures of firms' technological choices: capital intensity and firm size in terms of the natural logarithm of total assets. As discussed above, a firm's capital intensity can be seen as a proxy for work-force human capital. We follow MP by measuring a firm's capital intensity in terms of the ratio between the value of a firm's "property, plants, and equipment" and the number of its employees.

The main dependent variables of our analysis will be financial leverage and risk, defined (as in MP) as the volatility of a firm's operating profitability. Financial leverage is measured in terms of the ratio of the book value of a firm's debt and the firm's total assets figure. Operating profitability is measured in terms of return-on-assets (RoA), i.e. the ratio between a firm's earnings before interest and taxes, and it's lagged total assets figure. In each year, the volatility of RoA is measured over the past five years. If the requisite data are available for only less than four consecutive years during the five-year window, a firm-year is excluded from the estimation sample. RoA-volatility depends both on the firm's exposure to exogenous risk, as well on (endogenous) risk associated with the firms' choices and operating policies (e.g., shut-down policies).

We match the firm-level data to weather data that we obtained from the Austrian Central Institute for Meteorology and Geodynamics (AIMG). The matching is based on an algorithm that assigns each firm a weather station in the network that the AIMG uses in order to monitor the weather in Austria. The algorithm chooses the weather station located at the minimal Euclidean distance from the coordinates of the postal office in the firm's ZIP code. Since these weather stations are (for maintenance reasons) usually located in ski resorts, they tend to record the weather in the resorts close to the firms. These records can be used in order to compute measures of weather risk. Our main measure will be the coefficient of variation of the number of days during which there was more than 10 centimeters of snow on the ground. This number is recorded on a monthly basis. We add the numbers for the months of December and March of the following year, and do so for each year since the year 1973, which is the first year for which the data is available. Then, we compute the coefficient of variation of the sum across all years. This measure of weather risk varies across locations, but is constant over time. We will document below that weather risk causes demand risk, and will therefore use our measure of weather risk as a proxy for an exogenous risk to which the firms in our sample are exposed.

Besides firm-level data and weather data, we also use census data that we received from the Austrian Statistical Office "Statistics Austria" (SA). The latter data can be used in order to construct measures of aggregate weather exposure of hotel businesses based on "arrivals-counts", i.e. counts of the number of tourists who arrived in hotels. These arrivals-counts are available by winter season and municipality (postal code). We again use the coordinates of the postal offices associated with different postal codes in order to assign each municipality a weather station. We then add the arrivals counts of all municipalities assigned to one weather station in order to generate a total arrivals number for the region around the weather station, and to measure the exposure to weather risk of the region's hotel businesses (as discussed below).

Besides arrivals counts, the SA also reports counts of hotel businesses and the hotels' total number of beds, by municipality and year. We use these data in order to compute the total number of hotels in the region around a weather station, and the hotels' total number of beds (i.e. their total accommodation capacity). Panel A of Table 1 reports annual averages of the counts of hotel businesses (RegNoFirms), their accommodation capacity (RegCapacity), and arrivals by region/weather station, across all years for which we have firm-level data in our estimation sample (defined below), i.e. the years 1999-2007.

3.2 Regional weather exposure

We measure regional weather exposure based on coefficients of normalized weather realizations in regressions explaining the total arrivals number in the region around weather station r in year t:

$$\begin{aligned}\text{Arrivals}_{r,t} \;=\; & \beta_S \text{SnowDays}_{r,t} + \beta_A \text{SnowDays}_{r,t} \times \text{Altitude}_r \\ & + \beta_Y \text{SnowDays}_{r,t} \times \text{Year}_t + \beta_{AY} \text{SnowDays}_{r,t} \times \text{Altitude}_r \times \text{Year}_t \\ & + \nu_r + \tau_t + \epsilon_{r,t} \qquad (1)\end{aligned}$$

where ν_r and τ_t are fixed effects, SnowDays is the (normalized) number of days in December of year t and the following March during which there was more than 10 centimeters of snow on the ground, and Altitude is the altitude of the weather station where the weather is recorded. As discussed above, the latter variable proxies for the altitude of ski resorts. The number of SnowDays is normalized by demeaning and dividing by the standard deviation of the number of days with more than 10 centimeters of snow on the ground, where the mean and the standard deviation are computed across all records that are available for a weather station.

The coefficients of the above-stated regression measure the extent to which arrival counts depend on weather realizations, and the coefficients β_Y and β_{AY} measure variation in the weather exposure across years. Such variation is likely to exist because of ski resorts investing in equipment to create artificial snow, changes in such equipment's efficiency and deployability, and changes in aggregate volume flexibility associated with changes in industry structure.

We estimate the regression for the period 1999-2007 for which we have firm-level data. Table 3 reports the estimates. In the year 1999, a one-standard deviation increase in snow days (i.e. roughly 5 days) during the months of December and (the following) March caused additional $0.318 - 0.264 = 0.054$ millions of arrivals in ski resorts around a weather station at an altitude of 1000 meters, i.e. an increase of about 10% of the average number of arrivals (i.e. 0.515 millions, see Table 1). The estimates also show that the weather exposure of ski resorts is decreasing over time, with most of the decrease occurring in ski resorts around weather stations at low altitudes. Since the altitude of weather stations proxies for the altitude of ski resorts, the latter effect seems likely to be a consequence of ski resorts investing in equipment to generate artificial snow.

The estimates in Table 3 will be used in our firm-level analysis below. We will compute estimates of regional weather exposure, i.e. the effect of an increase in snow days for each weather station/region r and year t:

$$\text{RegExp}_{r,t} = \beta_S + \beta_A \text{Altitude}_r + \beta_Y \text{Year}_t + \beta_{AY} \text{Altitude}_r \times \text{Year}_t, \quad (2)$$

where the βs are the estimates from (1). As discussed above, this measure of regional weather exposure will change over time for a number of reasons, one of which may be changes in industry structure that cause changes in aggregate volume flexibility. We will not be able to identify effects of changes of the latter sort. The exposure measure will instead be used in a broader sense as a proxy for weather exposure that is exogenous at the level of individual firms.

3.3 Firm-level analysis

To explain policy choices of individual firms in our analysis, we condition on other policy choices of the same firms. We will therefore specify an empirical model in which the leverage, capital intensity and operating risk of firms are jointly determined in a system of equations. Such a model also appears in MP. Our specification differs from theirs in that we can include a number of exogenous variables that plausibly determine the firms' profits, leverage, and exogenous operating risk.

The exogenous variables in our analysis are variables that describe the firms' output markets. In order to ensure that the latter variables are reasonably exogenous, we focus on firms with a regional market share of less than 10%, where market share is measured in terms of accommodation capacity, i.e the ratio of a firm's number of beds to the total number of beds of all firms in the area of the weather station assigned to the firm. This criterion defines our "estimation sample". On average, the firms in the latter sample have a market share of 2% of accommodation capacity; for the full sample, the corresponding average equals 20%.

3.3.1 Descriptive statistics

Table 2 presents descriptive statistics for our full sample (Panel A) and the observations in our estimation sample (Panel B). Given the market-share criterion which defines the estimation sample, it is not surprising that there are differences in firm size. The firms in our estimation sample are significantly smaller, and the difference is significant also in economic terms in that these firms' mean total assets differ from the mean total assets in the full sample by 15%. There also is a statistically significant difference in terms of leverage, but this difference is not substantial at all. It thus seems that we have not introduced too much of a selection bias by focusing on firms with a small market share.[4] There are no significant differences in terms of any of the other firm-level variables.

Panel B of Table 1 reports descriptive statistics about the markets of the firms in our estimation sample, where each "market" is defined as the region around a weather station. Relative to the full sample, the estimation sample contains markets with more firms in regions at higher levels of altitude, with more snow and less snow risk.

3.3.2 Reduced-form estimates

We start the analysis by presenting reduced-form estimates for regressions of the endogenous firm-level variables on the regional variables that are reasonably exogenous at the level of the firms in our estimation sample. Table 4 presents such estimates for all of the five firm-level variables: capital intensity,

[4]Market share is to a large extent exogenously determined by entry barriers. For example, many hotels are in villages in which the availability of construction sites is limited by avalanche dangers and features of the terrain. Moreover, most villages have issued restrictive building codes in order to preserve their "character".

firm size, operating risk, profitability, and leverage. Each of these regressions is specified in first differences in order to difference-out firm-specific effects:[5]

$$\begin{aligned}\Delta y &= f(\Delta \text{RegExp}, \Delta \text{SnowDays}, \Delta(\text{SnowDays} \times \text{RegExp}), \\ &\quad \Delta(\text{SnowRisk} \times \text{RegExp}), \Delta \text{controls}, \text{year dummies}) + \varepsilon\end{aligned}$$

where y denotes the value of a firm-level variable, RegExp denotes the measure of regional weather exposure that we computed for the estimates in Table 3 according to expression (2), SnowDays and SnowRisk are our measures of weather-induced demand shocks and demand risk, and the control variables are the number of hotel businesses in firm i's region, RegNoFirms, and these businesses aggregate accommodation capacity, RegCapacity. We cannot include SnowRisk by itself since this variable is time-invariant.

The estimates in Panel A concern the variables describing the firms' technologies (capital intensity and firm size), as well as RoA volatility, and Panel B adds the estimates regarding profitability and leverage. The F statistics at the bottom of the tables show that the set of explanatory variables has explanatory power with respect to the capital intensity, profitability, and leverage of firms, but not with respect to firm size and RoA volatility.

The estimates for profitability (return on assets) show that the firms' profits depend on the weather realization. An increase in snow days by one standard deviation (i.e. about 5 days) increases the return on assets by about 0.3%, i.e. 5% of average RoA. This finding implies that the firms have limited opportunity to hedge weather risk.

We also find that profitability depends strongly and negatively on the aggregate accommodation capacity of a region. An increase in accommodation capacity by one standard deviation decreases profitability by about 10%. The existence of the latter effect is important for the analysis below, because we will use our proxies for regional market structure (i.e. the number of firms,

[5] We have checked that standard fixed-effects regressions yield very similar estimates. We report estimates for first differences in order to remain consistent with the regressions below.

and their aggregate capacity) as control variables that are supposed to capture effects of profitability on leverage.

The estimates for leverage show that the weather also affects the firms' capital structures. Exogenous improvements in business conditions – i.e. an increase in the number of snow days – have opposite effects on leverage and profitability: additional snow days increase profits, and decrease leverage. This result suggests that some firms use "windfall" profits to repay debt, consistent with prior empirical evidence of a negative relation between the leverage and profitability of firms.[6] Leverage also depends on market structure, in that firms with more competitors have higher leverage. We will control for this effect in the analysis below.

3.3.3 The Effect of Risk on Firm Leverage

We now present results for regressions explaining firm leverage based on exogenous and endogenous explanatory variables. We regress leverage on risk measured in terms of the standard deviation of firms' operating profits. Moreover, we will estimate regressions in which we control for capital intensity and firm size, i.e. proxies for firms' technological choices. Finally, we will analyze the effect of exogenous risk on firms' financial structures.

Throughout the analysis, we will control for effects of differences in the structure of the hotel industry across regions by including the number of hotel businesses in a region and their aggregate capacity as control variables. Moreover, we will allow for variation in the coefficients of all firm-level variables

[6] Frank and Goyal (2009) find that the negative relation between US listed firms' leverage and profits is one of five "core determinants" of leverage, but that the importance of profitability as a determinant of leverage declines over time. They attribute this stylized fact to capital market development. Rajan and Zingales (1995) conduct a cross-country analysis and find that the relation between leverage and profitability of firms is not always statistically significant, but they also document that the relation is negative for all countries in which they find a statistically significant relation.

across regions with different exposure to weather risk. We will therefore interact our measures of regional weather exposure with the firm-level variables.

We specify the following regression:

$$\begin{aligned}\Delta\text{Leverage} &= g(\Delta\text{RegExp}, \Delta\text{SnowDays}, \Delta(\text{SnowDays} \times \text{RegExp}) \\ &\quad \Delta\text{SnowRisk}, \Delta(\text{SnowRisk} \times \text{RegExp}), \Delta X, \Delta(X \times \text{RegExp}), \\ &\quad \Delta\text{controls}, \text{year dummies}) + \nu\end{aligned}$$

where the terms in the first line measure effects of changes in business conditions due to weather exposure, and the terms in the second line measure effects of exogenous risk (SnowRisk) and firm-level measures of risk/technology X. This specification can be compared with that of MP in that the vector X will include many of the firm-level variables that MP use in order to explain leverage, i.e. cash-flow volatility, the capital/labor ratio, and firm size (the natural logarithm of total assets).[7] We will in fact start the analysis by estimating models that only include these firm-level variables. Moreover, we will follow MP's approach in terms of estimation technique, by using GMM to address endogeneity bias in a specification based on first differences, where lagged levels are used as instruments. We however deviate from their approach by using system GMM (Arellano and Bover (1995)), rather than first-difference GMM. We do so in order to be able to include our time-invariant measures of weather risk. Coefficients of time-invariant variables are identified in system GMM because the instruments for the levels-equation (lagged first-differences) are assumed to be orthogonal to all time-invariant variables. This assumption seems safe with respect to our time-invariant weather risk measures.

[7]MP regress leverage on profitability of firms. In our specification, we control for exogenous determinants of profitability, i.e. market structure. We do not include measures of diversification of firms across business lines and Tobin's q since our data are about firms in only one line of business (hotels) that are also very similar in terms of their investment opportunities. Moreover, the firms in our sample are non-listed businesses, such that it would be impossible to compute the standard measure of Tobin's q.

Table 5 show the estimates. The standard errors are clustered at the regional level, and are small-sample corrected. The number of clusters (regions) is reported at the bottom of the table, along with the number of observations and the instrument count. We report the instrument count following a suggestion of Roodman (2009) who points out that instrument proliferation can bias GMM estimates due to overfitting of endogenous variables, and can weaken Hansen's J-test of overidentifying restrictions. We heed these warnings by collapsing the instruments, as suggested by Roodman (2009, 2010). The instrument counts in Table 5 are for the collapsed instruments.

The first set of estimates includes only one firm-level variable, i.e. the risk of firms' operating cash flows. We find that riskier firms use more debt financing. This result is consistent with prior evidence in MP. We however document that the effect varies in firms' exposure to exogenous (weather) risk. In more exposed regions, riskier firms (in terms of firm-level risk) use less debt financing than in less exposed regions. While the latter effect looses statistical significance if we add the other firm-level variables (i.e. the capital labor ratio, and firm size), it is again statistically significant once we also add weather risk. This result can be interpreted as a consequence of variation in the risk-taking incentives associated with debt financing. Under this interpretation, the result suggests that less leverage is required in order to induce risk-taking by owners of firms that are more exposed to exogenous risk.

The main result in Table 5 concerns the direct effect of exogenous risk: we find that such risk has a negative causal effect on the extent to which firms use debt financing, and that the coefficient of the firm-level risk measure decreases when we add our weather risk measure to the regression. This result shows that different types of risk have qualitatively different effects on firms' financing choices. It puts into perspective a number of contradictory findings about the relation between leverage and firm-level risk in the related literature, where this relation has been found to be positive (Kim and Sorensen (1986), MP), negative (Bradley, Jarrell and Kim (1984)), and insignificant (Titman and Wessels (1988)). Our findings suggest that these contradictory results have been obtained because firm-level risk was measured in terms of proxies for both endogenous and exogenous risk, but these two types of risk have opposite effects on leverage.

The negative effect of exogenous risk on leverage is consistent with the trade-off theory of capital structure choice. According to this theory, firms' optimal use of debt financing depends on a trade-off between the expected benefits of such financing in terms of tax-savings associated with tax-deductible interest payments, and expected costs of debt financing, such as bankruptcy costs. While both the benefits and the costs of debt financing can depend on a firm's exposure to exogenous risk, the theory is consistent with our findings if exogenous risk increases the expected (bankruptcy) costs of debt financing by more than the expected benefits.

The effect of exogenous risk on leverage is economically significant. Ignoring the interaction with regional weather exposure, a one-standard deviation increase in exogenous risk decreases leverage by $0.1 * 0.477 = 4.8\%$. However, a much bigger effect of exogenous risk is obtained if we include the interaction of exogenous risk and regional weather exposure in the estimate. While the coefficient of this interaction is not too far from being statistically significant, it is measured with too much error for a precise estimate of the economic magnitude of the effect of a change in exogenous risk on leverage. A rough revised estimate is a reduction in leverage of $(0.1 + 0.467 * 0.37) * 0.477 = 13\%$.

3.4 The Effect of Leverage on Risk

In our analysis, we regard risk and leverage as two variables that cause each other on the firm-level. We next specify a regression for analyzing cash flow volatility as an effect of exogenous risk and risk-taking incentives of firms' owners due to leverage:

$$\begin{aligned}\Delta\text{RoAVola} &= g(\Delta\text{RegExp}, \Delta\text{SnowRisk}, \Delta(\text{SnowRisk} \times \text{RegExp}) \\ &\quad \Delta X, \Delta(X \times \text{RegExp}), \Delta\text{controls}, \text{fixed effects}) + \mu\end{aligned}$$

where the terms in the first line measure effects of exogenous risk due to weather exposure of firms, and X denotes a vector of firm-level variables: leverage, capital intensity, and firm size. We first include only leverage, in order to measure the unconditional effect of risk-taking incentives associated with leverage, and then extend the specification in order to measure the incremental effect of leverage on cash flow volatility, given the effects of capital intensity and firm size as proxies for technology choices of firms.

The estimates appear in Table 6. We find that leverage indeed causes risk-taking. Ignoring the (marginally significant) effect of the interaction between leverage and regional weather exposure, a one standard-deviation increase in leverage adds 2% of RoA-volatility. This result is consistent with prior findings of MP.

Besides endogenous risk associated with leverage, exogenous risk determines the riskiness of individual firms. An increase in snow risk by one standard deviation adds $0.016 * 0.477 = 0.7\%$ of RoA-volatility, i.e. an increase of 15% relative to the mean RoA-volatility of 5.1%. The effect of regional weather exposure has the right sign, but the coefficient is measured with too little precision in order to judge its economic significance.

Overall, our results are consistent with the notion that RoA-volatility measures both endogenous and exogenous risk. These results thus support the view that prior analyses of the relation between firm-level risk and leverage led to contradictory results because of a failure to distinguish between different types of risk at the firm-level. We find that exogenous risk induces firms to turn away from debt financing, but we also find that debt financing creates risk-taking incentives. Exogenous risk matters not only directly, but also as a determinant of the size (and, perhaps even the direction) of risk-taking incentives associated with debt financing. The latter result provides empirical support for Ross' (2004) warning that the size and even the direction of such incentives generally depends on endogenous changes in the risk aversion of the decision makers. We show that risk-taking incentives depend on firms' exposure to exogenous risk.

4 Conclusion

According to the trade-off theory of debt financing, one can expect a negative relationship between exogenous risk and leverage, due to bankruptcy costs. On the other hand, the well-known "gambling for resurrection" argument suggests a positive relationship between leverage and risk, due to risk-taking incentives. These opposite effects are hard to disentangle unless one can isolate exogenous risk. The analysis in this paper is based on a sample of firms for which we can measure their exposure to exogenous risk. The firms are hotel businesses in Austrian ski resorts that are exposed to weather risk due to weather-induced demand shocks: demand drops if there is no snow, but hotels in different regions are exposed to this risk to different extents.

We have analyzed the relation between the firms' exposure to exogenous business risk and their financing choices. The results show that firms more exposed to exogenous risk use less debt financing. We have also analyzed the relation between the volatility of the firms' returns-on-assets, and their use of debt financing. The result is the opposite of that obtained for exogenous risk: we find that riskier firms use more debt financing. Overall, our results show that different types of risk are associated with different financing choices. While exogenous risk causes firms to use less debt financing, debt financing causes firms to take risk endogenously. This result explains contradictory findings regarding the relation between risk and debt financing in the prior literature. It suggests that the contradictory findings resulted from a failure to distinguish between exogenous and endogenous risk. Risk is not simply risk.

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Table 1: Descriptive statistics for regional variables. Panel A reports descriptive statistics for the full sample. Panel B reports the corresponding numbers for the estimation sample. Arrivals is the number of arrivals of tourists during the winter season, in millions of arrivals. Altitude is the altitude of the weather monitoring station associated with a region, in thousands of meters. SnowDays is the sum of the number of days during December and the following March on which the weather station recorded a snow level in excess of 10cm. SnowRisk is the coefficient of variation in this number of days across all available records per weather station. RegNoFirms is the total number of hotel businesses in the region, in thousands of firms, and RegCapacity is these businesses' total number of beds, in millions of beds. Starred values in Panel B indicate means which are statistically significantly different from the corresponding means in Panel A.

		Panel A			**Panel B**		
Variable	Unit: 10^x	No Obs	Mean	StDv	No Obs	Mean	StDv
Arrivals	6	588	0.515	3.458	381	0.792	4.316
Altitude	3	588	0.761	0.422	381	0.857*	0.457
SnowDays	0	588	10.93	10.71	381	12.90*	11.02
SnowRisk	0	588	0.859	0.498	381	0.753*	0.477
RegNoFirms	3	588	0.231	0.882	381	0.345*	1.087
RegCapacity	6	588	0.017	0.100	381	0.026	0.121

Table 2: Descriptive statistics for firm-level variables. Panel A reports descriptive statistics for the full sample. Panel B reports the corresponding numbers for the estimation sample. The capital/labor ratio is the value of a firm's property, plants and equipment per employee. Leverage is the ratio of the book value of total debt to total assets. RoA is the ratio of EBIT to lagged total assets. All Euro amounts are in millions of Euros. Starred values in Panel B indicate means which are statistically significantly different from the corresponding means in Panel A.

		Panel A			**Panel B**		
Variable	Unit: 10^x	No Obs	Mean	StDv	No Obs	Mean	StDv
Captl/Labor	6	11950	0.133	0.339	4389	0.138	0.454
Total assets	6	13200	4.427	8.476	4514	3.770*	5.516
Leverage	0	11932	0.949	0.368	4092	0.976*	0.343
RoA	0	9710	0.065	0.128	4327	0.067	0.097
Vola RoA	0	4404	0.049	0.066	1423	0.051	0.077

Table 3: Regional weather exposure: arrival counts (in millions of arrivals) are regressed on the normalized number of days in December of year t and the following March during which a region's weather station recorded more than 10 centimeters of snow on the ground: SnowDays is this number of days demeaned and divided by the standard deviation of the number of days with more than 10 centimeters of snow on the ground, where the mean and the standard deviation are computed across all records that are available for the weather station. Altitude is the weather station's altitude, in thousands of meters. Year is the number of years since 1999 (i.e. zero for observations in the year 1999).

Arrivals: OLS Estimates		
	Coef	p
SnowDays	0.318	0.004
SnowDays×Altitude	-0.264	0.022
SnowDays×Year	-0.056	0.004
SnowDays×Altitude×Year	0.044	0.023
Year dummies	Yes	
Regional fixed effects	Yes	
R2 (within)	4%	
No Regions	87	
No Observations	588	

Table 4: OLS estimates for regressions explaining firm-level variables. The dependent variables in Panel A are (1) capital intensity measured in terms of the capital/labor ratio, i.e. the ratio of a firm's property, plants, and equipment (in millions of Euros) per employee, (2) firm size measured in terms of natural logarithm of total assets in Euros, and (3) operating risk in terms of the volatility of returns-on-assets. The dependent variables in Panel B are (4) operating risk, (5) profitability measured in terms of the return on assets (RoA), i.e. the ratio of EBIT to lagged total assets, and (6) leverage in terms of the ratio of the book value of total debt to total assets. The explanatory variables are (i) the weather exposure of arrivals of tourists in a firm's region, denoted as RegExp and defined as in expression (2) based on the estimates in Table 3, (ii) the interaction between RegExp and SnowRisk, where SnowRisk is defined as the coefficient of variation (by weather station) of the number of days in December of any year t and the following March during which a region's weather station recorded more than 10 centimeters of snow on the ground, (iii) SnowDays i.e. the demeaned number of days in December of year t and the following March during which a region's weather station recorded more than 10 centimeters of snow on the ground, normalized by SnowRisk, (iv) the interaction of SnowDays and RegExp, (v) RegNoFirms i.e. the total number of hotel businesses in the region, and (vi) these businesses' total number of beds, denoted as RegCapacity. All standard errors are adjusted for regional clustering.

Reduced Form in 1st Differences: OLS Estimates							
Panel A: Capital Intensity, Firm Size, and Operating Risk							
		(1)		(2)		(3)	
		Capital Intensity		Firm Size		Risk	
		Capital/Labor		ln(Tot Ass)		Vola RoA	
		Coef	p	Coef	p	Coef	p
RegExp	(i)	0.002	0.994	-0.206	0.487	-0.039	0.270
SnowRisk×RegExp	(ii)	-0.691	0.392	0.527	0.109	-0.013	0.748
SnowDays	(iii)	-0.017	0.268	-0.004	0.408	-0.001	0.674
SnowDays×RegExp	(iv)	-0.094	0.352	-0.116	0.117	0.002	0.878
RegNoFirms	(v)	-0.074	0.300	-0.036	0.837	0.001	0.923
RegCapacity	(vi)	-1.241	0.125	-0.675	0.201	-0.098	0.083
Year dummies		Yes		Yes		Yes	
F		22.39		4.47		1.79	
No Regions		66		66		55	
No Observations		4389		4514		1423	

Table 4, continued

Reduced Form in 1st Differences: OLS Estimates							
Panel B: Operating Risk, Profitability, and Leverage							
		(4)		(5)		(6)	
		Risk		Profitability		Leverage	
		StDv of RoA		RoA		Debt/Tot Ass	
		Coef	p	Coef	p	Coef	p
RegExp	(i)	-0.039	0.270	0.189	0.095	-0.100	0.502
SnowRisk×RegExp	(ii)	-0.013	0.748	-0.363	0.094	0.041	0.805
SnowDays	(iii)	-0.001	0.674	0.003	0.075	-0.004	0.045
SnowDays×RegExp	(iv)	0.002	0.878	0.028	0.242	-0.006	0.836
RegNoFirms	(v)	0.001	0.923	0.069	0.240	0.111	0.057
RegCapacity	(vi)	-0.098	0.083	-0.937	0.017	0.227	0.384
Year dummies		Yes		Yes		Yes	
F		1.79		21.21		18.78	
No Regions		55		66		63	
No Observations		1423		4327		4092	

Table 5: System GMM estimates for regressions explaining leverage at the firm-level. Leverage is measured in terms of the ratio of the book value of total debt to total assets. The explanatory variables are (i) the weather exposure of arrivals of tourists in a firm's region, denoted as RegExp and defined as in expression (2) based on the estimates in Table 3, (ii) SnowDays i.e. the number of days in December of year t and the following March during which the weather station in a firm's region recorded more than 10 centimeters of snow on the ground, demeaned and divided by the standard deviation of all such records that are available for the weather station , (iii) the interaction of SnowDays and RegExp, (iv) SnowRisk, defined as the coefficient of variation (by weather station) of the number of days in December of any year t and the following March during which a region's weather station recorded more than 10 centimeters of snow on the ground, (v) the interaction between SnowRisk and RegExp, (vi) operating risk in terms of the standard deviation of returns-on-assets (EBIT divided by lagged total assets), (vii) operating risk interacted with RegExp, (viii) - (xi) the capital intensity and size of the firm (by themselves, and interacted with RegExp), where capital intensity is measured in terms of the ratio of a firm's property, plants, and equipment (in millions of Euros) per employee, and firm size is measured in terms of natural logarithm of total assets in Euros, (xii) RegNoFirms i.e. the total number of hotel businesses in the region, and (xiii) these businesses' total number of beds, denoted as RegCapacity. All standard errors are adjusted for regional clustering.

See the next page.

Table 5

Leverage: System GMM Estimates							
		Coef	p	Coef	p	Coef	p
RegExp	(i)	0.396	0.205	-6.307	0.689	3.919	0.763
SnowDays	(ii)	-0.013	0.062	-0.017	0.018	-0.009	0.162
SnowDays×RegExp	(iii)	0.005	0.959	-0.045	0.725	-0.193	0.063
SnowRisk	(iv)					-0.100	0.025
SnowRisk×RegExp	(v)					-0.467	0.244
Risk (StDv of RoA)	(vi)	0.342	0.000	0.301	0.001	0.245	0.006
Risk×RegExp	(vii)	-4.694	0.045	-2.165	0.128	-2.570	0.031
CapIntsty (Capital/Labor)	(viii)			-0.014	0.940	-0.150	0.418
CapIntsty×RegExp	(ix)			-1.724	0.765	-1.353	0.803
FirmSze (ln(Total Assets))	(x)			-0.131	0.073	-0.220	0.003
FirmSze×RegExp	(xi)			0.462	0.685	-0.222	0.809
RegNoFirms	(xii)	0.051	0.400	0.197	0.040	0.155	0.130
RegCapacity	(xiii)	-0.327	0.527	-1.562	0.059	-1.118	0.212
Year dummies		Yes		Yes		Yes	
F		22.20		21.79		23.48	
No Firms		784		781		781	
No Regions		60		60		60	
No Observations		2103		2086		2086	
No Instruments		22		58		58	
Hansen test: p		0.497		0.485		0.729	

Table 6: System GMM estimates for regressions explaining the volatility of firms' returns-on-assets (RoA, i.e. EBIT divided by lagged total assets). The explanatory variables are (i) the weather exposure of arrivals of tourists in a firm's region, denoted as RegExp and defined as in expression (2) based on the estimates in Table 3, (ii) SnowRisk, defined as the coefficient of variation (by weather station) of the number of days in December of any year t and the following March during which a region's weather station recorded more than 10 centimeters of snow on the ground, (iii) the interaction between SnowRisk and RegExp, (iv) leverage in terms of the ratio of the book value of total debt to total assets , (v) leverage interacted with RegExp, (vi) - (ix) the capital intensity and size of the firm (by themselves, and interacted with RegExp), where capital intensity is measured in terms of the ratio of a firm's property, plants, and equipment (in millions of Euros) per employee, and firm size is measured in terms of natural logarithm of total assets in Euros, (x) RegNoFirms i.e. the total number of hotel businesses in the region, and (xi) these businesses total number of beds, denoted as RegCapacity. All standard errors are adjusted for regional clustering.

See the next page.

Table 6

RoA Volatility: System GMM Estimates					
		Coef	p	Coef	p
RegExp	(i)	0.788	0.144	6.996	0.201
SnowRisk	(ii)	0.005	0.363	0.016	0.096
SnowRisk×RegExp	(iii)	-0.051	0.554	-0.065	0.701
Leverage (Debt/Total Assets)	(iv)	0.033	0.077	0.076	0.021
Leverage×RegExp	(v)	-0.767	0.133	-0.717	0.119
CapIntsty (Capital/Labor)	(vi)			-0.122	0.277
CapIntsty×RegExp	(vii)			-0.209	0.931
FirmSze (ln(Total Assets))	(viii)			0.039	0.031
FirmSze×RegExp	(ix)			-0.416	0.226
RegNoFirms	(x)	-0.005	0.715	-0.033	0.228
RegCapacity	(xi)	0.054	0.668	0.269	0.256
Year dummies		Yes		Yes	
F		44.76		10.71	
No Firms		784		781	
No Regions		60		60	
No Observations		2103		2086	
No Instruments		30		66	
Hansen test: p		0.378		0.498	