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journal homepage: www.elsevier.com/locate/jfecEntrepreneurial risk, investment, and innovation[☆]Andrea Caggese^{a,b,*}^a Pompeu Fabra University, 08005 Barcelona, Spain^b Barcelona Graduate School of Economics, Barcelona, Spain

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ABSTRACT

I estimate the effect of uncertainty on risky innovation using a panel of 11,417 manufacturing firms. I find that an increase in uncertainty has a large negative effect on the risky innovation of entrepreneurial firms, while it does not have any significant impact on other firms. This negative effect is stronger for the less diversified entrepreneurial firms in the sample. The estimation results are consistent with the innovation dynamics generated in a model in which entrepreneurs are risk averse and cannot diversify the risk of their business.

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1. Introduction

This paper provides new empirical evidence on the effect of uncertainty on innovation. It simulates a model of an

entrepreneurial firm and derives testable predictions concerning the relation between financial market frictions, uncertainty, and the decisions to undertake risky productivity-enhancing projects. It then tests these predictions on a data set of 11,417 Italian manufacturing firms. The unique feature of this data set is that it combines a large panel of yearly balance sheet data, for the 1992–2001 period, with three qualitative surveys, conducted in 1995, 1998, and 2001. The surveys include detailed information concerning firms' property structure, their investment in different types of innovation, their financial constraints, and other relevant information that can be used to control the robustness of the results, such as their degree of internationalization and their market structure.

The empirical analysis identifies a significant and large negative effect of uncertainty on the innovation of entrepreneurial firms, of a magnitude comparable to the negative effect found in the calibrated model. Because the level of uncertainty faced by firms varies significantly in the business cycle, this finding could have important consequences for both business cycle fluctuations and growth.

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Entrepreneurial firms are an engine of innovation and technological progress, and they are likely to be responsible for a substantial portion of productivity and employment growth. Despite several recent studies emphasizing the importance of financial factors for the creation and development of new entrepreneurial firms, little is known about the effect of uncertainty on entrepreneurial investment decisions.¹ However, this problem is likely to be important, because entrepreneurial households appear not to be able to diversify the risk of their business. Moskowitz and Vissing-Jørgensen (2002) analyze US data and show that 48% of all private equity is owned by households for whom it constitutes at least 75% of their total net worth. Furthermore, Bitler, Moskowitz, and Vissing-Jørgensen (2005) provide evidence that agency considerations play a key role in explaining why entrepreneurs on average hold large ownership stakes, indicating that their lack of diversification is driven by market imperfections, not by risk-loving preferences.²

Does uncertainty prevent entrepreneurs from investing in risky and innovative projects? In this paper I answer this question by testing the following hypothesis: In an industry in which innovation is risky, uncertainty should negatively affect the innovation of entrepreneurial firms far more than that of publicly owned firms. Because of capital market imperfections, entrepreneurial households have most of their wealth invested in their own businesses. Therefore, in response to an increase in uncertainty, their main instrument to rebalance the risk-return profile of their assets is the choice of the riskiness of their investment projects. The same effect does not operate in publicly owned firms, in which the firm's manager is exposed only to a fraction of the firm's risk and can more easily diversify it.

In the paper I first conduct a simulation exercise as a preliminary step before the actual estimation with the empirical firm-level data. In the model an entrepreneurial firm maximizes the intertemporal consumption of its owner-manager. It can invest in its own production and borrow or lend at the risk-free rate. The production function is linear in technology and concave in capital, and it is also subject to exogenous profit shocks. Moreover, the firm can improve its technology by investing in innovative projects that are risky and yield an uncertain return. The only instrument available to partially insure against profits and innovation shocks is to save in the risk-free asset.

I use the model to simulate many identical firms that differ only in the realization of their shocks. In the benchmark case, the firms can borrow up-front the net present value of future earnings. Because this collateral constraint is almost never binding, they can almost always implement their optimal risk-adjusted investment

decisions. The parameters are calibrated so that the volatility of profits matches that observed for the Italian firms in the empirical sample.

These simulations show a substantial negative effect of uncertainty on risky innovation, especially for the firms with lower levels of financial assets. I then simulate several firms with debt limited by a tighter exogenous borrowing limit, and I show that lowering such limit reduces both the frequency of innovation and its sensitivity to changes in uncertainty. This occurs because the innovation decision of an undiversified entrepreneurial firm that also faces a binding borrowing constraint is determined by the current availability of credit, not by uncertainty concerning future profits. These results indicate that to verify the uncertainty–innovation hypothesis, it is necessary to properly identify the presence of borrowing constraints.

After conducting this preliminary simulation exercise, the main section of this paper verifies empirically the following predictions.

Prediction i. An increase in the volatility of the exogenous profits shocks reduces the risky innovation of entrepreneurial firms. This reduction is stronger the less diversified firms are.

Prediction ii. The negative effect of uncertainty on the innovation of entrepreneurial firms is dampened by the presence of firms facing binding borrowing constraints.

Prediction iii. A change in exogenous uncertainty does not affect the investment in innovation for all firms when the innovation risk is very low.

The first part of the empirical section of the paper illustrates and checks the validity of the assumptions adopted to select the group of entrepreneurial firms and to identify the risky innovation decisions. Then Prediction i is verified with a panel data estimation in which the innovation decisions of the firms are regressed on the level on uncertainty, lagged one period, as well as on other control variables, on time dummies, and on two-digit sector dummies.

As a measure of uncertainty I consider the volatility of the profits/assets ratio, computed for every period across firms for every three-digit sector. The use of a sector-specific measure of the volatility of profits avoids possible reverse causality problems. Nonetheless, estimation results could still be biased by unobservable factors affecting both the dispersion of profits across firms and their innovation decisions. However, the test predicts a negative uncertainty–innovation relation for entrepreneurial firms only. Therefore, any unobserved factor that affects this relation in the same direction for all firms is likely to bias the test toward rejecting, not accepting, the hypothesis. Moreover, several robustness checks are performed in the paper to ensure that the results are not driven by an endogeneity problem. First, I consider a panel regression in which I introduce fixed effects at the three-digit level, so that the uncertainty coefficient is identified only by changes in uncertainty within sectors instead of by differences across sectors. Second, I verify that both the pooled and the fixed effect regressions are also consistent with Predictions ii and

¹ Among the studies on financial factors and entrepreneurship, see Evans and Jovanovic (1989), Holtz-Eakin, Joulfaian, and Rosen (1994), Gentry and Hubbard (2004), and Hurst and Lusardi (2004).

² Supporting this conclusion, experimental studies generally find entrepreneurs to be as risk averse as—and some studies find them to be even more risk averse than—nonentrepreneurs (Saravathy, Simon, and Lave, 1998; Miner and Raju, 2004; Hongwei and Ruef, 2004).

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