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Uncertainty, investment, and managerial incentives

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ABSTRACT

This study provides evidence that managerial incentives, shaped by compensation contracts, help to explain the empirical relationship between uncertainty and investment. We develop a model in which the manager, compensated with an equity-based contract, makes investment decisions for a firm that faces time-varying volatility. The contract creates incentives that affect both the sign and magnitude of a manager's optimal response to volatility shocks. The model is calibrated using compensation data to quantify this predicted investment response for a large panel of firms. Our estimates help explain the variation in firm-level investment responses to volatility shocks observed in the data.

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1. Introduction

An empirical literature in macroeconomics and finance has found a strong connection between uncertainty shocks and capital investment policies.¹ Theoretical explanations for the response of investment to changes in idiosyncratic volatility have traditionally focused on the real option feature of investment. With costly reversibility, an increase in volatility changes the optimal timing of investment.² In addition, following the financial crisis of 2007–2009, imperfections in financial markets have been explored as a potential mechanism that generates the observed link between uncertainty and investment.³

In this paper we investigate the role of an agency conflict between a firm's manager and shareholders in explaining the relationship between uncertainty and investment. Increasingly, compensation contracts for executives of US public firms consist largely of own-company stock and options. These contracts expose a manager to firm-specific risk, which is not borne by diversified shareholders. This drives a wedge between the pricing kernels, and therefore optimal investment policies, of a firm's manager and diversified shareholders. If shareholders are unable to perfectly monitor managers, firm investment policies observed in the data are likely to reflect the manager incentives induced by the compensation contract. Importantly, the manager's optimal response to an uncertainty shock will depend on the structure of their incentive-based compensation contract.

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E-mail addresses: gloverb@andrew.cmu.edu (B. Glover), olevine@bus.wisc.edu (O. Levine).¹ See, for example, Leahy and Whited (1996), Guiso and Parigi (1999), Bloom et al. (2007), Panousi and Papanikolaou (2012), Bachmann et al. (2013), and Gilchrist et al. (2013).² See, for example, Brennan and Schwartz (1985), McDonald and Siegel (1986), and Dixit and Pindyck (1994).³ Gilchrist et al. (2013) explore this effect in a model that also features capital irreversibility and investigate the quantitative impact of each mechanism.

We show that this agency conflict is important in understanding the response of investment to volatility shocks. To quantify the investment incentives of the manager, we develop a neoclassical model of firm investment that embeds an agency conflict between the manager and outside shareholders. Firms are operated by managers who are compensated with their own company's stock and options, in addition to a fixed salary. Thus, the model explicitly links manager compensation contracts to optimal firm investment policies and provides predictions for the relationship between idiosyncratic volatility shocks, the compensation contract, and a manager's optimal investment policy.

The model predicts a conditional relationship between firm-specific uncertainty and investment that can vary across firms and over time. We show that an increase in firm-specific uncertainty can incentivize a manager to either increase or decrease firm investment, where the sign and magnitude of the response depend on the structure of the compensation contract.

We use firm-level data on production and compensation contracts for a sample of US public companies over the period 1956–2012 to calibrate the model to match firm-year-level variation. From the calibrated model, we compute the optimal investment response to a volatility shock for a manager with the observed compensation contract. We do this for each firm-year in our sample and compare this panel of estimated manager investment incentives to the investment policies that would be optimal for a diversified shareholder.

The panel of predicted manager investment responses to volatility shocks, which are estimated from the model, exhibit significant cross-sectional and time series variation. Moreover, we show that the predicted manager responses have strong predictive power for firms' observed investment responses to volatility shocks in the data. In particular, we find that the documented negative relationship between volatility and investment is only present for those firms that provide compensation contracts that predict this negative response. Taken together, our results suggest that understanding the structure of executive compensation contracts is important for understanding the link between uncertainty and investment observed in the data.

A significant strand of the investment literature has theoretically characterized the effect of uncertainty on optimal investment policies under different conditions for the firm's production technology, capital adjustment costs, the market structure, and risk aversion. One set of results finds that greater uncertainty can generate an increase in firm investment. If a firm's profits are convex in costs or demand, and the firm is able to easily scale up or down, then greater uncertainty increases the marginal value of an additional unit of capital and, consequently, investment.⁴ A second set of results has predicted a negative relation between uncertainty and investment. These papers show that with costly reversibility of capital, an increase in uncertainty can increase the value of the option to delay investment and result in a drop in investment. This real options effect generally predicts that the investment response to an increase in uncertainty will be negative as a firm's optimal inaction region expands.⁵ Thus, the response of investment to uncertainty predicted by economic theory can be ambiguous and depends critically on the assumptions of the model environment.⁶

The empirical literature on the relationship between uncertainty and investment has, in most cases, found a negative relationship, whereby an increase in uncertainty predicts a reduction in investment. Leahy and Whited (1996) study the empirical relationship between uncertainty, measured using the volatility of firm equity returns, and investment for a panel of US manufacturing firms. They find that uncertainty has a strong negative impact on investment and that this is driven by idiosyncratic, firm-level uncertainty, not a priced source of systematic risk. Bloom et al. (2007) take a similar approach, using data for UK manufacturing firms for the period 1972–1991. They find evidence that the investment behavior of large manufacturing firms is consistent with a real options effect generated by costly reversibility.

Bachmann et al. (2013) use business survey data for the US and Germany in a structural VAR framework and find that innovations in uncertainty have a negative impact on economic activity. They find these effects to be prolonged, however, and argue that the observed responses are not consistent with the delay and fast rebound that would be predicted by a real options effect. Guiso and Parigi (1999) study a sample of Italian manufacturing firms and measure uncertainty using the subjective probability distribution of demand reported by the entrepreneurs in their sample. They find that this measure of uncertainty displays a negative relation with the responsiveness of investment, consistent with a real options effect.

Panousi and Papanikolaou (2012) investigate the uncertainty-investment relationship by estimating panel regressions for US public firms, using idiosyncratic equity return volatility as their measure of uncertainty. They find a negative relationship between investment and uncertainty and show that the magnitude of this effect is increasing in the fraction of insider ownership. They attribute these results to the impact of undiversified idiosyncratic risk borne by managers that have incentive-based compensation packages.

The empirical results of this paper are complementary to those of Panousi and Papanikolaou (2012) in that we also find an important role for executive compensation contracts in shaping firms' investment response to uncertainty shocks. Additionally, our structural model allows us to compute a manager's predicted response to an uncertainty shock for each firm and year in our sample. We show that there is significant variation, both in the cross-section and time series, in our estimates of a manager's optimal response to an uncertainty shock. Specifically, we find that some managers receive compensation contracts that incentivize them to increase investment following an uncertainty shock.

⁴ See Oi (1961), Hartman (1972), and Abel (1983).

⁵ See, e.g., Bernanke (1983), Brennan and Schwartz (1985), McDonald and Siegel (1986), Pindyck (1988), and Dixit and Pindyck (1994).

⁶ For more on this, see Caballero (1991), Abel et al. (1994), Abel et al. (1996), Abel and Eberly (1996), and Abel and Eberly (1999).

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