The Finance Uncertainty Multiplier

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18/3/2020

Motivation

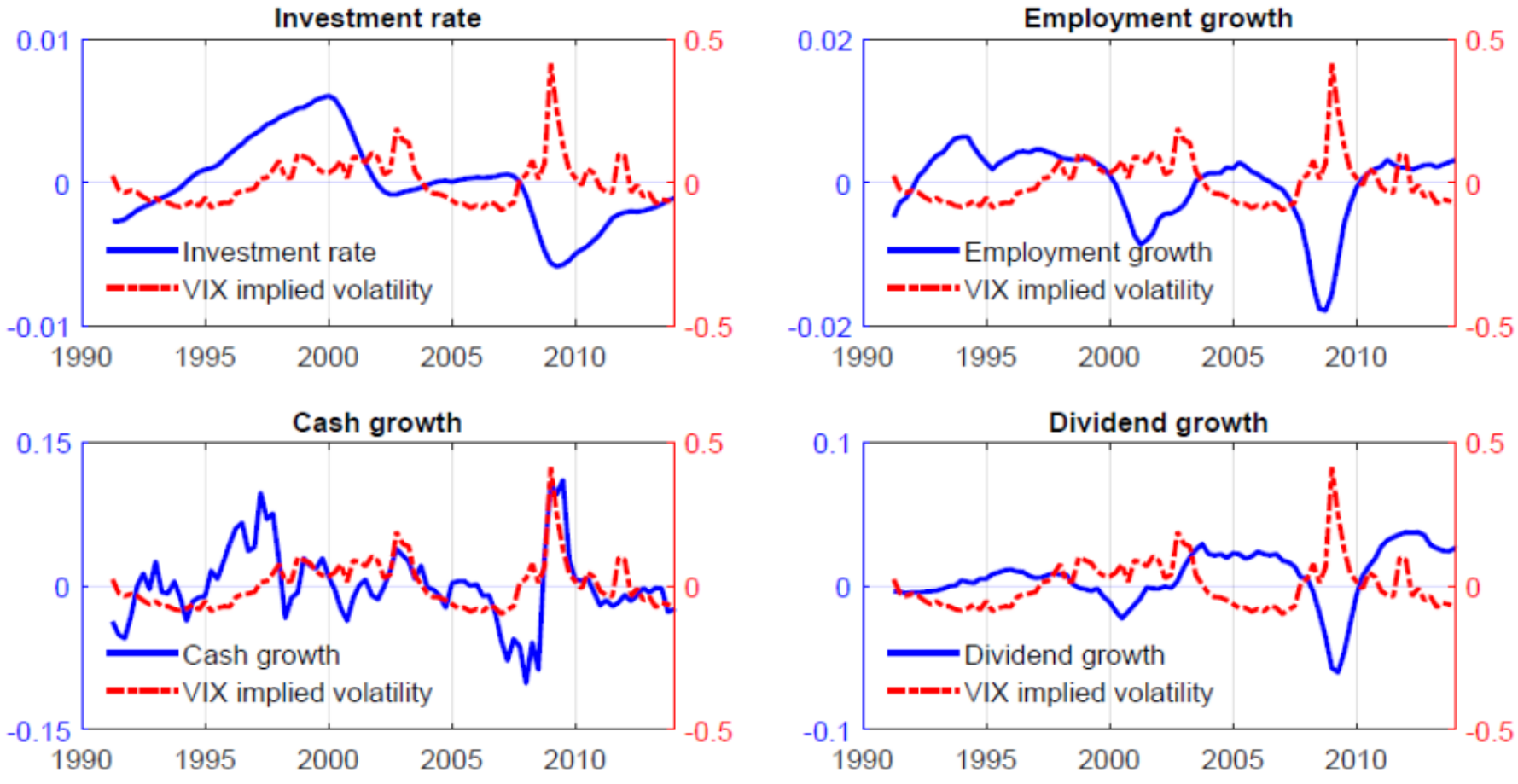
Question: do real and **financial frictions** amplify and propagate the effects of **uncertainty shocks** on investment, employment and financial variables?

"Uncertainty shocks":

- Micro (e.g firm growth) or macro (e.g GDP growth, other)
  → Macroeconomic uncertainty typically proxied by the **VIX index**
- Both increase during crises
- **Here**: effect of an increase in firm-level uncertainty on the firms' decisions
  → Real options/growth options/other effects?

Motivation

Figure 1: Uncertainty, real outcomes and financial flows



The paper

Empirical part

- Provide causal empirical support to identify the **impact of uncertainty on investment, employment...**
- Take endogeneity seriously: novel instrumentation strategy
- Results

  $\rightarrow$ Higher uncertainty reduces investment, employment... while increasing cash holdings

  $\rightarrow$ Financial conditions affect sensitivity to uncertainty

The paper

Theoretical part

- Heterogeneous-firms dynamic model with real and **financial frictions** + cash
- Address the mechanism driving that causal relationship: real options + **cash options**
- Calibrate and simulate the model to mimic empirical regressions
- Results:
  $\rightarrow$ Financial frictions amplify effect of uncertainty shocks on GDP, increase persistence, and propagate to financial variables

EMPIRICAL ANALYSIS

Data and variables

Data

- CRSP: stock returns (to measure uncertainty)
- Compustat: annual accounting variables (firm features)
- January 1963 to December 2016, period: year

Variables

- Uncertainty: two alternative measures
  $\rightarrow$ Realised volatility: standard deviation of daily cum-dividend stock returns
  $\rightarrow$ Implied volatility: average of daily implied volatility values of forward call options

Data and variables

- Investment rate (dependent variable), $\frac{I_{i,t}}{K_{i,t-1}}$
- Controls: standard
  $\rightarrow$ Lagged levels of Tobin's Q
  $\rightarrow$ Lagged stock return of the firm
  $\rightarrow$ Lagged levels of book leverage ...
- Firm and time fixed effects

Idea: regress real and financial variables (e.g investment rate) on **lagged uncertainty shocks**, $\Delta Volatility_{i,t-1}$

Identification strategy

Firm-level uncertainty (either realised/implied) might be endogenous!

Idea:

- Exploit firms' different exposure to some aggregate volatility shocks...
- ...to identify an exogenous part of the change in firm-level uncertainty

We consider shocks to **10 sources of uncertainty**:

- Oil prices
- 7 currencies
- Interest rates
- Policy

Identification strategy

(Basic idea, no refinements) Building the instruments in **two steps**:

1. Estimate industry sensitivities: regress daily stock return on changes in 10 sources of aggr. uncertainty

$$r_{i,t}^{risk\_adj} = \alpha_j \sum_c \beta_{\mathbf{j}}^{\mathbf{c}} r_t^c + \epsilon_{i,t}$$

2. Multiply time-varying sensitivities by implied volatilies, for each of the 10 shocks

$$z_{i,t-1}^c = |\beta_{j,t-\tau}^c| \Delta\sigma_{t-1}^c$$

Allow for **2SLS instrumented firm-level uncertainty shocks**, $\hat{\Delta\sigma}_{i,t-1}^{2SLS}$

Results (brief) - Real and financial variables

An increase in uncertainty...

- **Investment rate**: uncertainty shocks lead to significant drops in investment (Sargan does not reject validity of instruments)
- **Real variables (sales, employment...)**: negative and significant effect
- **Financial variables**: effects are significant
  $\rightarrow$ Firms reduce their debt and equity payouts
  $\rightarrow$ Firms increase their cash holdings

Results (brief) - Financial frictions

Do we have causal support for the **interaction of financial frictions and uncertainty shocks**?

1. Whether investment rate is more sensitive to uncertainty shocks in **periods with higher financial frictions**.
2. Whether intensity is amplified for **ex-ante financially constrained firms vs. unconstrained**

The answer is yes in both cases.

We have causal empirical support. What are the mechanisms driving these results?

THE MODEL

Main ingredients

- Continuum of heterogeneous firms, discrete and infinite time
- **Frictions** (two different specifications)
  $\rightarrow$ Real frictions - adjustment costs
  $\rightarrow$ Financial frictions - cost associated to external financing
  (reduced form)
- **Firms' choices**: maximize mkt value of equity
  $\rightarrow$ Labour and capital
  $\rightarrow$ Cash holdings (manage risk by saving in cash)

Technology and uncertainty

- **Revenue function**:

$$S(Z_t, K_t, L_t) = Z_t^{1-a-b} K_t^a L_t^b$$

where Z_t depends on $\tilde{Z}_t$ (firm's productivity)

- **Productivity**: firm-specific productivity process

$$z_{t+1} = \rho_z z_t + \sigma_t \varepsilon_{t+1}^z$$

- **Uncertainty**: two-point Markov chain

$$\sigma_t \in \{\sigma_L, \sigma_H\}$$

Technology and uncertainty

- Nonconvex adjustment costs:

$$G_t = c_k S_t \mathbb{1}_{\{I_t \neq 0\}}$$

- Fixed production cost $F_t = fZ_{t-1}$ (for motivating firms to hold cash, to cover these costs)
- **Operating profit**

$$\Pi_t = S_t - WL_t - F_t$$

- **Payout before financing cost**

$$E_t = \Pi_t - I_t - H_t - G_t$$

where H_t is the investment in cash

External financing costs

$\eta_t \in \{\eta_L, \eta_H\}$, a two-point Markov chain, captures the **time-varying financial conditions**

The **external financing costs** (reduced form) are:

$$\Psi_t = \phi(\eta_t, \sigma_t)|E_t|\mathbb{1}_{\{E_t<0\}}$$

Notice that they also depend on uncertainty in a positive fashion: $\phi(\eta_t, \sigma_H) = \eta_t + \lambda$, with $\lambda > 0$, while $\phi(\eta_t, \sigma_L) = \eta_t$

Firm's problem

$$V_t = \max_{\{I_t, L_t, K_{t+1}, N_{t+1}\}} E_t - \Psi_t + \beta \mathbb{E} V_{t+1}$$

subject to

$$K_{t+1} = I_t + (1 - \delta) K_t$$

$$N_{t+1} = H_t + (1 - r_n) N_t$$

CALIBRATION AND RESULTS

Procedure

- Calibrate 14 parameters, θ
  $\rightarrow$ 10 parameters from literature
  $\rightarrow$ 4 parameters estimated with **Simulated Method of Moments (SMM)**
- Confront actual moments in data Ψ^A with those from simulating the model, $\Psi^S(\theta)$, given a guess θ, to minimise a criterion

- Estimated parameters: $c_k, \eta_L, \eta_H, \lambda$
- Targets: **coefficients of the multivariate 2SLS regressions** of investment rate, employment growth, cash growth and dividend growth
  $\rightarrow$ want simulated data to mimic the actual data regressions

Results - Specifications

The preferred identification is the one with **both real and financial frictions**

- **Drops in investment and employment** $\rightarrow$ REAL OPTIONS effects
- **Rising cash holdings** $\rightarrow$ CASH OPTIONS effects
- Results are significant, when estimating using the simulated data

Results - Intuition for the mechanism

Figure 3: Investment policy functions

Figure 3A: Real costs only

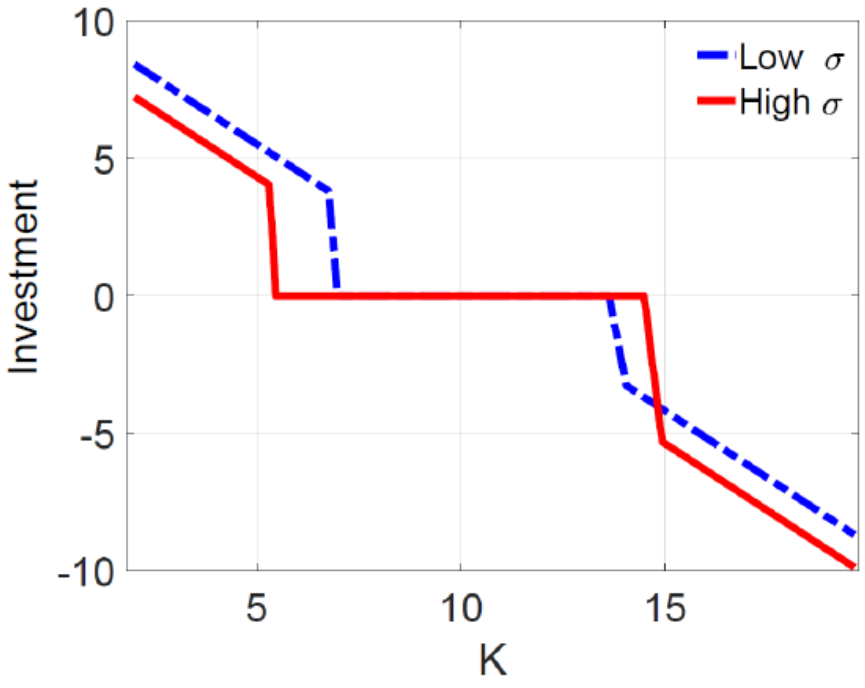
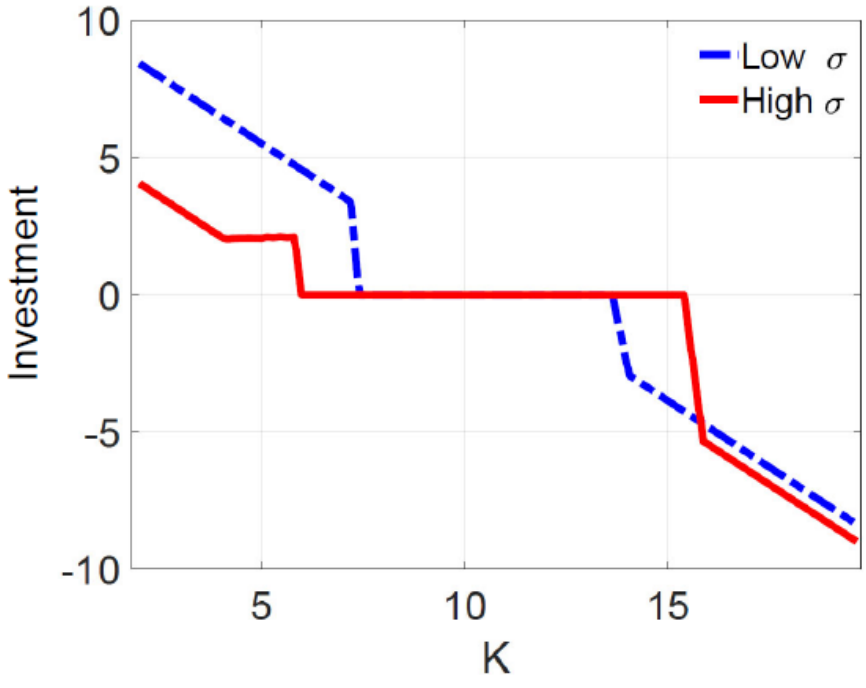


Figure 3B: Baseline: real and financial costs



Results - Amplification

The role of **financial frictions**...

1. Amplification: they **double** the negative impact of uncertainty shocks on investment and hiring. Larger drop in output with financial frictions (3.6% vs 1.7%)

2. Persistence: they **double** the duration of these drops (impulse response functions)

3. Propagation to financial variables: classical model fails to generate

Conclusion

Empirical analysis

- Causal empirical support to
  $\rightarrow$ Investment falling/cash holdings increasing with uncertainty
  $\rightarrow$ Financial frictions interacting with uncertainty shocks

Theoretical model

- Calibration matches real data on investment and cash holdings well
- Amplification, persistence and propagation to financial variables