Information Choice and Shock Transmission

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Motivation

Cross-country differences in impact of 2007-2008 crisis:

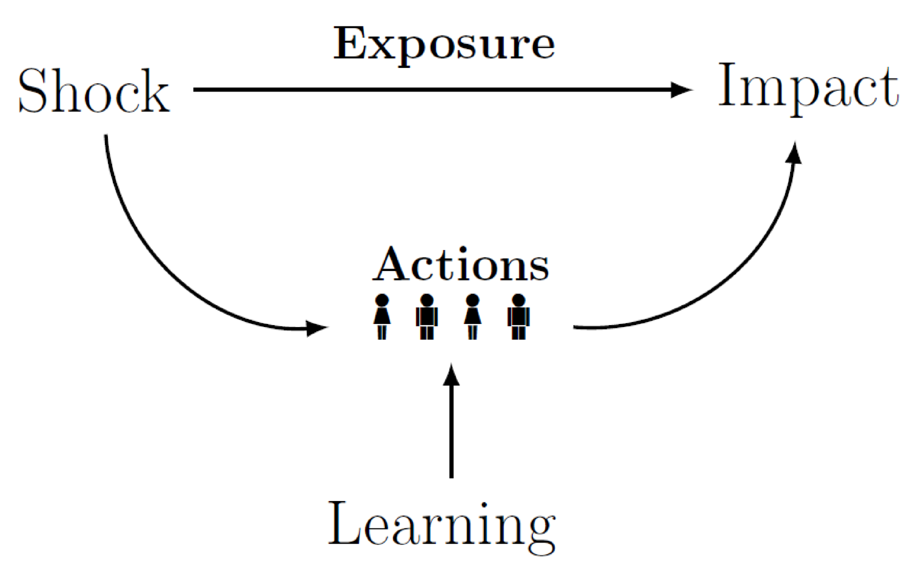
- countries relatively more exposed to the crisis country, the United States, were among the least affected in real terms (Rose and Spiegel, 2010, 2011)
- equity portfolios relatively more exposed to the crisis country experienced the lowest declines in returns (Bekaert, Ehrmann, Fratzscher, and Mehl, 2014)

Question

How can the impact of a shock decrease with exposure to it?

Intuition

Impact of shock depends not only on direct exposure, but also on decision-makers reactions to this shock, which depend in turn on the information set of decision-makers



Study role of endogenous information choice in the transmission of shock through the actions of decision-makers

Contribution

- Novel theory of shock transmission which can explain the empirically observed negative correlation between the degree of exposure to a shock and the impact of that shock
- Information theoretic microfoundation of contagion manifested as shock amplification that sheds light on two important dimensions: (i) which of the shocks that an entity is exposed to are likely to amplify, and (ii) which of the entities exposed to a shock are likely to be more affected
- Model predicts that under certain conditions the transmission of shocks is intensified as exposure to shocks decreases, which implies that: (i) the shocks that an entity is less exposed to are amplified, and (ii) the entities that are less exposed to a shock are relatively more affected

Model

- Risk-neutral, representative firm
- Firm chooses level of investment λ to maximize profits

$$\pi = \lambda\theta - C(\lambda)$$

- Return on investment θ depends on economic fundamentals

$$\theta = \alpha f_1 + (1-\alpha) f_2$$

where α and $1-\alpha$ are exogenous exposures to risk factors f_i, $i = 1,2$

$$f_i = \mu_i + \epsilon_i$$

where μ_i are constants and ϵ_i are shocks $\epsilon_i \sim \mathcal{N}(0,\sigma_i^2)$.

- Uncertainty is reduced by acquiring signals about shocks

$$s_i = \epsilon_i + \epsilon_{s_i}$$

where $\epsilon_{s_i} \sim \mathcal{N}(0,\sigma_{s_i}^2)$, $i = 1,2$

Learning constraints

choose information	observe information | invest	payoff
$t=1$	$t=2$	$t=3$

- Learning follows Bayes' rule and yields posterior uncertainty

$$\hat{\sigma}^2 \equiv \mathrm{Var}[\theta|s_1,s_2] = \alpha^2\hat{\sigma}_1^2 + (1-\alpha)^2\hat{\sigma}_2^2$$

- Capacity constraint:

$$k_1 + k_2 \leq K$$

where the factor-specific information processing capacity, k_i, is modelled using rational inattention (Sims, 2003)

$$k_i = \frac{1}{2}\ln\frac{\sigma_i^2}{\hat{\sigma}_i^2}, \quad i = 1,2$$

- No-forgetting constraint:

$$k_i \geq 0, \quad i = 1,2$$

Takeaway

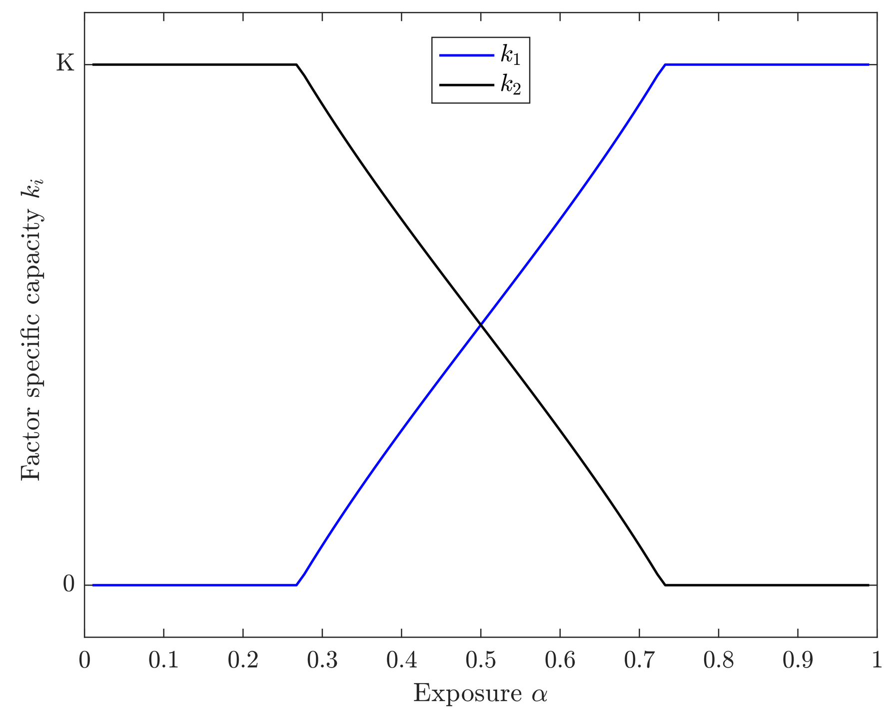
The paper proposes an information-based theory of shock transmission which explains how the impact of a shock can decrease with exposure to it. I develop a model in which decision-makers learn about the risk factors they are exposed to, but have limited capacity to process information. I find that decision-makers optimally learn more about the risk factors they are more exposed to, which enables them to mitigate the impact of shocks to these risk factors by minimizing the loss due to suboptimal action. On the other hand, the impact of shocks to risk factors that decision-makers are relatively less exposed to is amplified through their poorly informed decisions.

Optimal information choice

$$k_1 = \begin{cases} 0 & \text{if } \frac{\alpha\sigma_1}{(1-\alpha)\sigma_2} < e^{-K} \\ \frac{1}{2}\left(K + \ln\frac{\alpha\sigma_1}{(1-\alpha)\sigma_2}\right) & \text{if } e^{-K} \leq \frac{\alpha\sigma_1}{(1-\alpha)\sigma_2} \leq e^{K} \\ K & \text{if } \frac{\alpha\sigma_1}{(1-\alpha)\sigma_2} > e^{K} \end{cases}$$

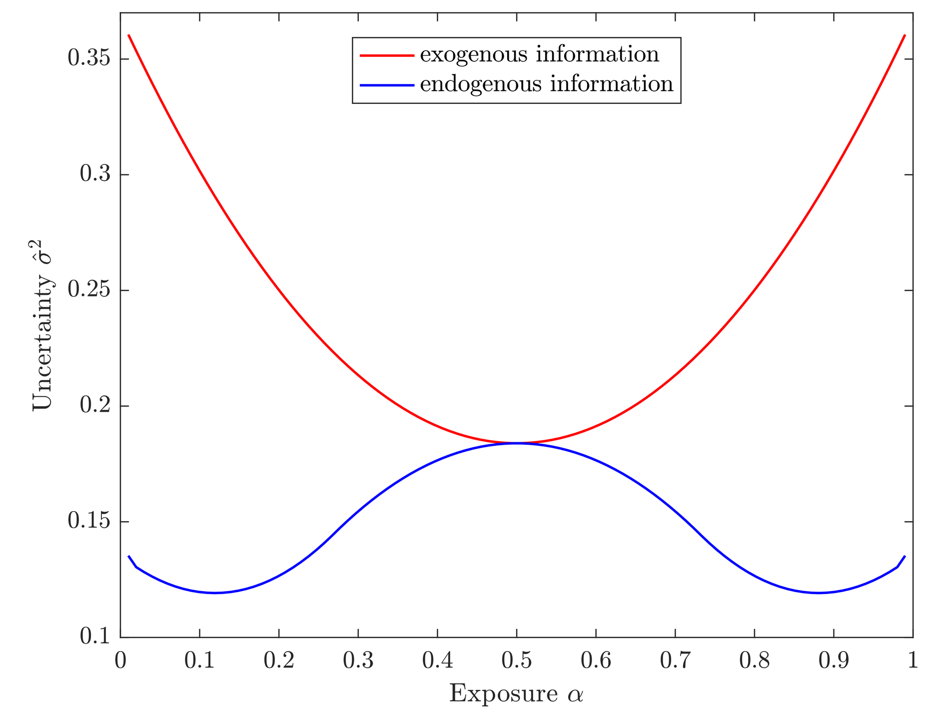
$$k_2 = K - k_1$$

Optimally learn more about risk factors more exposed to. If exposure to factor 1 is sufficiently low, firm optimally chooses not to learn about it and instead devotes all information processing resources to learning about factor 2, and viceversa.



Implications in terms of uncertainty

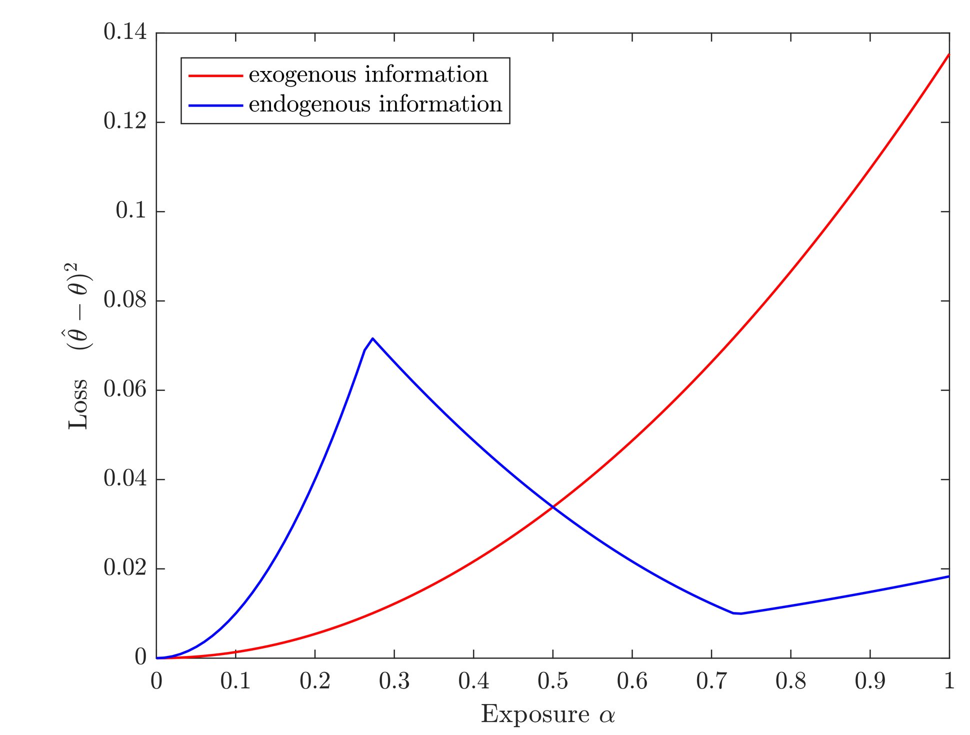
When optimally learning about both risk factors, uncertainty decreases with exposure if a risk factor is relatively important in terms of exposure, i.e. $\frac{\partial\hat{\sigma}^2}{\partial\alpha}$ if $\alpha > 0.5$ and $k \in (0,K)$. Prediction stands in stark contrast to that of an exogenous information benchmark.



The 2007-2008 crisis was different because the crisis epicentre, the United States, plays an important role in the global economy so uncertainty dynamics follow pattern depicted at the right of the exposure midpoint, $\alpha > 0.5$.

Loss due to suboptimal investment

Loss due to suboptimal investment increases with exposure when information is exogenously given, but it decreases with exposure when information is endogenously chosen.



Relative to the exogenous information benchmark, impact of shocks to risk factors that are relatively less important in terms of exposure is amplified, while impact of shocks that are relatively more important in terms of exposure is attenuated.

Extensions

- Shock Anticipation: loss decreases with degree of anticipation i.e. unexpected shocks are amplified
- Strategic Interactions: loss increases (decreases) with degree of strategic complementarity (substitutability)
- Correlated Risks: loss increases with degree of correlation
- Endogenous Exposure: optimal to specialize in learning about and being relatively more exposed to one factor

Conclusions

- Study how endogenous information choices affect decision-makers' reactions to shocks, and as a consequence the impact of these shocks
- Characterize conditions under which impact of shocks can decrease with exposure
- Key mechanism is that learning increases with exposure, so the cost of being highly exposed to a shock is mitigated by the benefit of having a better understanding of it
- Contribute to understanding observed patterns of contagion by explaining how entities that are more exposed to a crisis can be less affected, and why contagion is more likely to occur following unexpected crises

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