Credit Frictions and the Extensive Margin [1]

Incomplete and very preliminary!

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[1]The views expressed do not necessarily reflect those of the Federal Reserve Bank of Dallas, or the Federal Reserve System.

Introduction

Objective:

- Examine the interaction between credit frictions, firm entry and exit, and macroeconomic activity
  - Credit frictions that arise due to asymmetric information
  - Economic activity on the extensive margin (firm entry and exit) and intensive margin (input), both depend on credit availability

Introduction

Model that builds on:

- Financial accelerator
  - Bernanke and Gertler (1989), Calrstrom and Fuerst (1997), Bernanke, Gertler, Gilchrist (1999)
- Firm entry and exit
  - Ghironi and Melitz (2007), Bilbiie, Ghironi, and Melitz (2012)
- Similar to:
  - Poutineau and Vermandel (2015) - bounded rationality
  - Bergin, et al (2014) - collateral constraint

This talk

Outline

- Empirical evidence on credit spreads and entry
- Brief overview of model
- Explore long-run properties (steady state)
- Wedge analysis

Preliminary empirics: data

- Data: 1981-2019
  - risk spread:BAA-10yrTbond
  - TFP, real GDP and investment growth
  - log birth rates (establishments) ('93 on)
  - log death rates (establishments) ('93 on)
  - Annual data on birth and death rates and on TFP dispersion

Contemporaneous cross-correlations

Table 1. Contemporaneous Correlations

Variable	TFP growth	GDP growth	Investnent growth	Spread	Birth rate	Death rate
TFP growth	1.00	0.74	0.45	−0.19	0.10	−0.07
GDP growth		1.00	0.71	−0.48	0.37	−0.22
Invest. growth			1.00	−0.51	0.31	−0.42
Spread				1.00	−0.61	0.12
Birth rate					1.00	0.34
Death rate						1.00

Preliminary empirics: correlations (Table 1)

- Cross correlations: Birth and death rates and economic activity
  - Positive correlation between real GDP, investment growth and birth rate
  - Negative correlation between real economic activity and death rate

Preliminary empirics: correlations (Table 1)

- Cross correlations with Spread
  - Strong negative correlation between spread and real economic activity (GDP, investment)
  - Even stronger negative correlation between spread and entry
  - Weak positive correlation between spread and exit

Preliminary empirics: Lead/lags (Table 2)

- Lead/lag correlations with Spread
  - Birth rate Lead correlation arguably stronger than contemporaneous correlation

Contemporaneous cross-correlations

Table 2. Cross-Correlations Leads and Lags

	Cross-Correlations with Spread						
	Leads				**Lags**		
Variable	**3**	**2**	**1**	**0**	**1**	**2**	**3**
TFP growth	0.17	0.15	0.03	−0.19	−0.25	−0.22	−0.20
GDP growth	−0.03	−0.12	−0.29	−0.48	−0.50	−0.45	−0.39
Invest.growth	−0.00	−0.13	−0.35	−0.51	−0.50	−0.45	−0.38
Spread	0.55	0.70	0.88	1.00	0.88	0.70	0.55
Birth rate	−0.67	−0.65	−0.65	−0.61	−0.55	−0.49	−0.45
Death rate	−0.16	−0.06	0.05	0.12	0.14	0.14	0.13

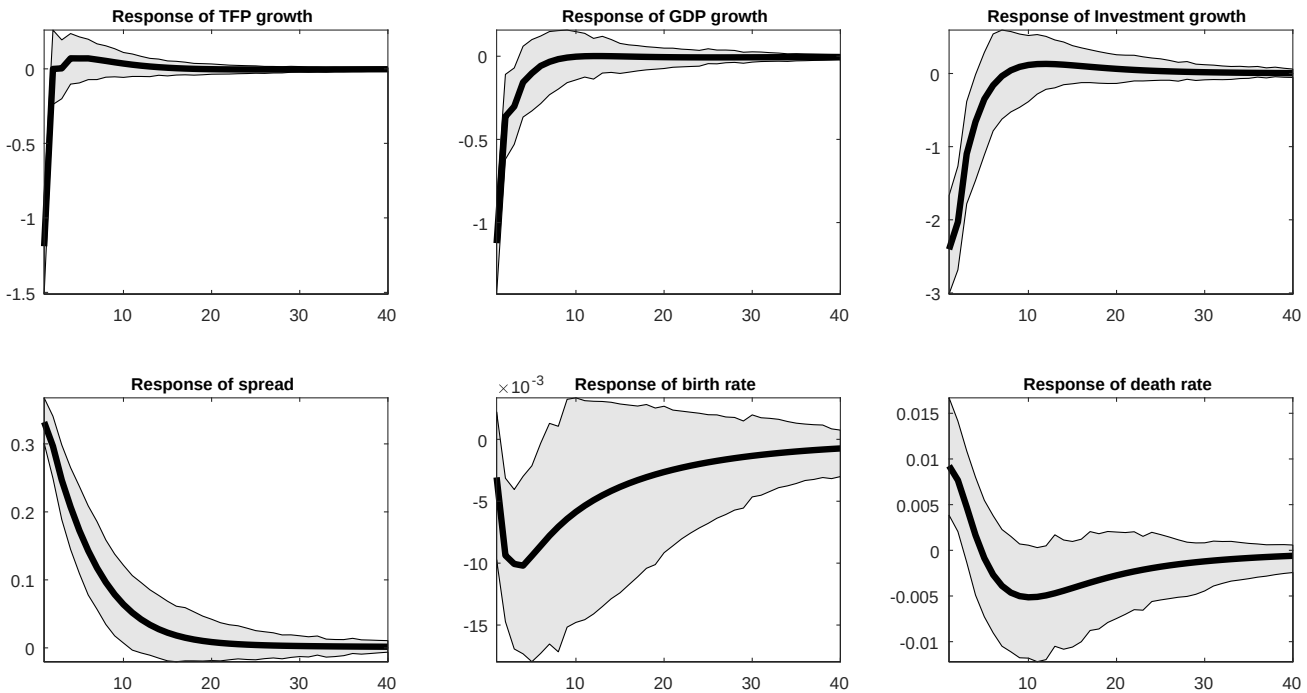
Preliminary empirics: Mixed Frequency VAR

- Quarterly variables: 1981-2019
  - TFP, GDP, Investment growth
  - BAA-10yrTbond spread
  - Establishment birth and death rates (post '93)
- Annual variables: 1981-2019
  - Establishment birth and death rates
  - Micro-uncertainty: dispersion in firm TFP (detrended)

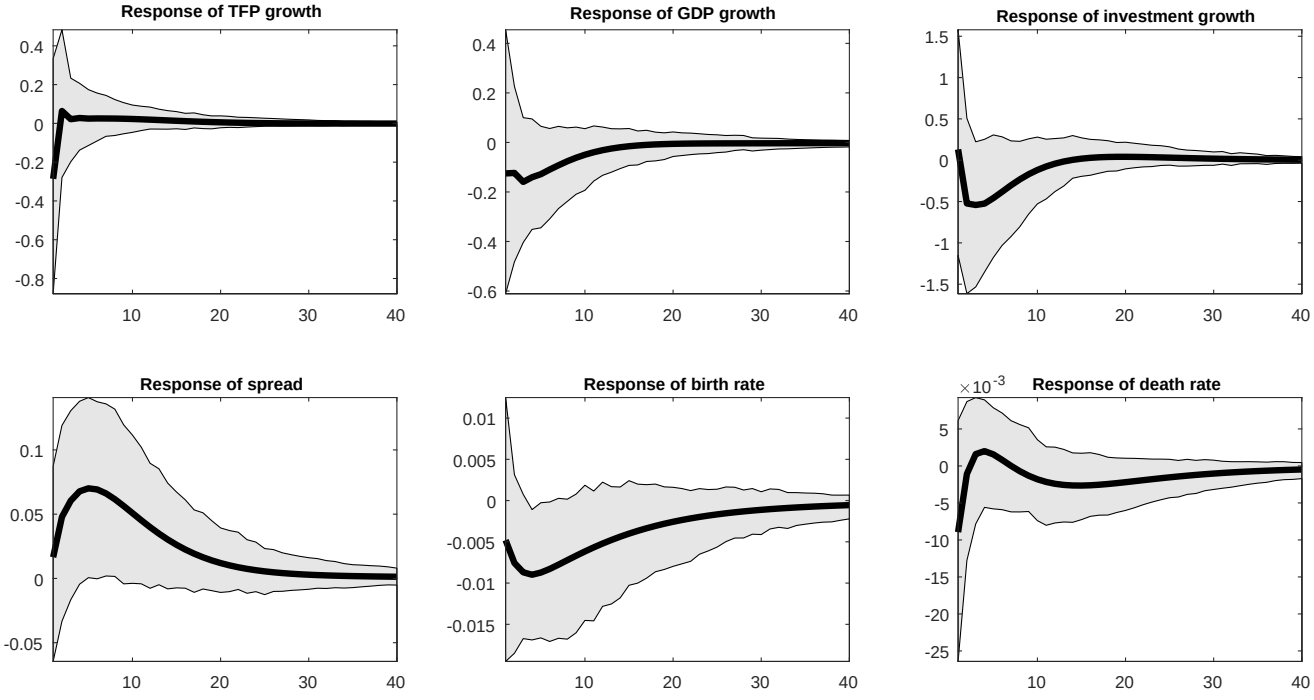
Preliminary empirics: Mixed Frequency VAR

- State space model
  - State equations: 7 variables in quarterly VAR
    - TFP, GDP, investment growth, spread, birth rate, death rate, micro-uncertainty
    - model micro-uncertainty strictly exogenous
  - Observation equation: 6 quarterly, 3 annual
    - Impose relationship between quarterly and annual variables
- Bayesian estimation
  - Modified Minnesota priors

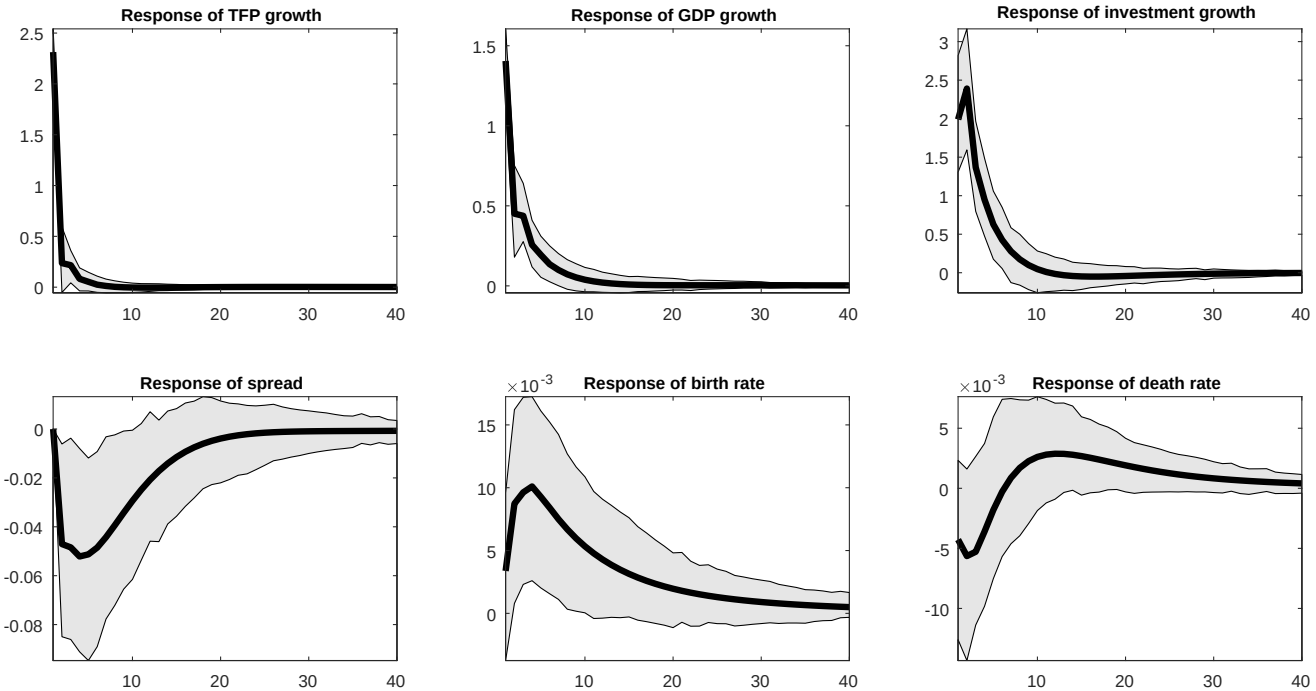
Mixed Frequency VAR impulse responses: spread shock



Mixed Frequency VAR impulse responses: micro-uncertainty shock



Mixed Frequency VAR impulse responses: TFP shock



Preliminary empirics: Mixed Frequency VAR

- Summary of results
  - Spread shocks (positive):
    - Declines in GDP and investment (TFP less so)
    - Decline in birth rate and increase in death rate
  - Micro-uncertainty:
    - Very imprecise effects
  - Entry and exit rates respond to economic activity

Model overview

Features of model

- Credit frictions due to asymmetric information:
  - Intensive margin
    - borrow working capital to pay inputs
    - borrow to finance investment projects
  - Extensive margin: firm entry and exit
    - "supply of new entrants"
    - exit as a result of default
    - credit frictions affect "demand for new entrants"
- Three spreads:
  - working capital loans
  - entry loans
  - investment loans

Model Overview: Working capital

- Existing firms
  - Must pay inputs before producing
  - Borrow working capital to pay inputs that cannot be paid from retained earnings
  - Degree of credit frictions depends on amount of micro-uncertainty and cost of monitoring
  - Incentive to hold retained earnings (not pay dividends)
- Credit frictions affect the cost of production and profits, hence, demand for entry

Model overview: Entry

- Combination of Carlstrom and Fuerst (1997) and Bilbiie, Ghironi, and Melitz (2012)
- Entrepreneurs:
  - Create firms
  - Obtain resources from net worth and loans
  - Degree of credit frictions depends on amount of uncertainty and cost of monitoring
- Credit frictions affect the cost of "entry services" and, hence, the supply of entry

Details: Production firms

- Face (inverse) Dixit-Stiglitz demands: $\rho_t(\epsilon) = \left(\frac{y_t(\epsilon)}{Y_t}\right)^{\frac{-1}{\theta}}$
  - $\rho_t(\epsilon) = \frac{p_t(\epsilon)}{P_t}$
  - $Y_t = \left[\int_0^{N_t} y_t(\epsilon)^{\frac{\theta-1}{\theta}} d\epsilon\right]^{\frac{\theta}{\theta-1}}$
  - $P_t = \left[\int_0^{N_t} p_t(\epsilon)^{1-\theta} d\epsilon\right]^{\frac{1}{1-\theta}}$
- Firm output, $y_t(\epsilon) = \epsilon_t y_t$
  - ϵ_t - idiosyncratic productivity (private information)
  - $y_t = z_t h_t^{\alpha} k_t^{(1-\alpha)}$, common across firms
- Firm revenue:
  - $\epsilon_t^{\left(\frac{\theta-1}{\theta}\right)} y_t^{\left(\frac{\theta-1}{\theta}\right)} Y_t^{\frac{1}{\theta}}$

Production firms

- Must pay input costs $(w_t h_t + r_{k,t} k_t)$ before observing ϵ_t
- Finance working capital from borrowing and past retained earnings
- Past retained earnings
  - $a_{F,t} = x_t(1 + r_{w,t})W_t$
    - x_t is firm's share of aggregate wealth
    - $(1 + r_{w.t})W_t$ is gross return on aggregate wealth

Production firms

- Default on loan if revenue fails to cover loan costs:
  - Define $\overline{\epsilon}_t$: $\overline{\epsilon}_t^{(\frac{\theta-1}{\theta})} y_t^{(\frac{\theta-1}{\theta})} Y_t^{\frac{1}{\theta}} = (1 + r_{F,t})(w_t h_t + r_{k,t} k_t - a_{F,t})$
  - Default if: $\epsilon_t < \overline{\epsilon}_t$
- Costly to observe for financial intermediaries (μ_F)
  - Only monitor if firm claims default

Production firms: loan contract

- Share of total output going to non-defaulting firms: $f_\epsilon(\overline{\epsilon}_t)$
- Share of total output going to financial intermediaries, $g_\epsilon(\overline{\epsilon}_t)$,includes:
  - Includes loans repaid by non-defaulting firms
  - Includes values of defaulting firms' output minus monitoring costs

Production firms: optimal loan contract

- Contract satisfies:
  - $(\frac{y_t}{Y_t})^{(\frac{-1}{\theta})} = m(\overline{\epsilon}_t)\lambda_t^C$
    - like setting "planned" price to be a markup over MC
    - λ_t^C is marginal cost
    - $m(\overline{\epsilon}_t)$ is markup
  - output depends on firm net worth (retained earnings): $y_t = \frac{a_{F,t}}{(1-m(\overline{\epsilon}_t)g_\epsilon(\overline{\epsilon}_t))\lambda_t^C}$
  - default cutoff $(\overline{\epsilon}_t)$ depends on net worth $(a_{F,t})$

Production firms: optimal retained earnings

- Choose retained earnings, $x_{F,t+1}$, to maximize PV of dividends
- Tradeoff between current dividends and future output (future dividends)
- Firm current dividends: $d_t = \left(\epsilon_t^{\frac{\theta-1}{\theta}} - \overline{\epsilon}_t^{\frac{\theta-1}{\theta}}\right) \frac{m(\overline{\epsilon}_t)}{1-m(\overline{\epsilon}_t)g_\epsilon(\overline{\epsilon}_t)} x_{F,t}(1+r_{w,t})W_t - x_{F,t+1}W_{t+1}$
- optimal retained earnings depends on:
  - markup
  - extent of credit frictions

Aggregate output

- $Y_t = \left(f_\epsilon(\overline{\epsilon}_t) + g_\epsilon(\overline{\epsilon}_t)\right)^{\frac{\theta}{\theta-1}} N_t^{\frac{\theta}{\theta-1}} y_t$
  - y_t per firm "planned" output
  - $\left(f_\epsilon(\overline{\epsilon}_t) + g_\epsilon(\overline{\epsilon}_t)\right)^{\frac{\theta}{\theta-1}}$ reflects the output loss due to firm defaults
  - N_t number of producing firms

Firm Dynamics

- total number of firms:
  $N_{t+1} = (1-\delta)(1-\Phi_\epsilon(\overline{\epsilon}_t))N_t + (1-\delta)N_t^0$
  - number of new entrants: N_t^0
  - exogenous death rate, δ.
  - working capital default probability $= \Phi_\epsilon(\overline{\epsilon}_t)$
- birth rate: N_t^0 / N_t
- death rate: $\Phi_\epsilon(\overline{\epsilon}_t) + \delta(1-\Phi_\epsilon(\overline{\epsilon}_t)) + \delta\frac{N_t^0}{N_t}$

Entrepreneurs and supply of new firms

Entrepreneurs:

- Provide "Entrepreneurial services"
  - Input in the creation of firm: fixed cost of creating a firm, $F_{E,t}$
  - Must borrow to finance production of entrepreneurial services
  - Entrepreneur productivity asymmetic information
  - Optimal loan contract similar to working capital contract (also similar to Calstrom and Fuerst).

Supply of entry services

- expected payoff to financial intermediaries: $p_{E,t} g_\omega(\overline{\omega}_t) E_t$
- expected payoff to entrepreneurs: $p_{E,t} f(\overline{\omega}_t) E_t$
- E_t depends on entrepreneur net worth, $A_{E,t}$
- total supply of entrepreneurial services produced:
  - $(f_\omega(\overline{\omega_t}) + g_\omega(\overline{\omega}_t))E_t = (1 - \mu_E)\Phi_\omega(\overline{\omega}_t)E_t$

Demand for new firms:Entry

- free entry: $v_t = p_{E,t} F_{E,t} + x_{t+1} W_{t+1}$
  - v_t = value of firm in initial public offering
  - $x_{t+1} W_{t+1}$ = funds required to finance 1st period working capital
  - Cost of entry: $p_{E,t} F_{E,t}$
    - $p_{E,t}$ = price of entrepreneurial services
    - $F_{E,t}$ = fixed amount of entry services required to create firm
    - allow for congestion effects $F_{E,t} = z_{E,t} \left(\frac{N_t^0}{N_{SS}^0} \right)^{\tau}$

Rest of model

- Households rent labor and capital to production firms
- Market clearing conditions for:
  - labor
  - capital rental market
  - consumption good
  - entrepreneurial services
  - investment services

Model: Calibration

- Table 3
- Use values of Carlstrom and Fuerst (1997) and Bilbiie et al (2012).
- Normalize z_{ss} and $f_{E,ss}$ so that $y_{ss} = 1$ and $N_{ss} = 1$

Steady state analysis: Table 4

- Baseline vs no credit frictions
  - Steady state ratios plausible (?)
  - Retained earnings 85% of earnings (vs 0% with no credit frictions)
- Examines how steady state changes if 20% increase over baseline values
  - TFP and increase in demand for variety (markup):
    - large effects on: number of firms, GDP
  - fixed entry costs and exogenous death rates:
    - large effects on: number of firms. GDP, consumption
    - valuation ratio falls with increase in death rate
  - micro-uncertainty
    - small effects on: number of firms. GDP
    - large effect on spreads

Steady state analysis: Table 4

Table 4. Steady State Sensitivity Analysis

Variable	Baseline	No credit frictions	20% increase in baseline specification							
			TFP	Markup	Entry Cost	Exogenous Death Rate	Working Capital Uncert.	Entry Uncert.	Investment Uncert.	All Uncert.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GDP	1.005	1.048	1.4	1.94	0.972	0.977	1.008	1.005	1.004	1.006
Per firm output (y)	1	0.887	0.967	0.232	1.226	1.174	0.978	1.004	1	0.982
Number of firms (N)	1	1.163	1.393	5.082	0.806	0.842	1.023	0.996	0.998	1.017
Birth rate (x100)	2.596	2.302	2.596	2.642	2.596	3.155	2.519	2.596	2.596	2.519
Price/dividend (v/d)	27.475	29.984	27.475	27.116	27.475	23.761	28.089	27.475	27.475	28.089
Spread entry loans (%)	1.871	0	1.871	1.871	1.871	1.871	1.871	2.301	1.871	2.301
Spread working capital loans (%)	1.871	0	1.871	1.607	1.871	2.320	2.127	1.871	1.871	2.127
Spread investment loans (%)	1.871	0	1.871	1.871	1.871	1.871	1.871	1.871	2.301	2.301
Investment share of GDP	0.221	0.226	0.221	0.184	0.221	0.221	0.221	0.221	0.221	0.212
Entry costs share of GDP	0.065	0.063	0.065	0.174	0.065	0.068	0.064	0.065	0.065	0.064
Retained earnings ratio	0.858	0	0.858	0.654	0.858	0.852	0.867	0.858	0.858	0.867
Working capital share of loans	0.499	0.759	0.499	0.527	0.499	0.509	0.387	0.504	0.517	0.411
Investment share of loans	0.387	0.189	0.387	0.243	0.387	0.375	0.474	0.391	0.365	0.457
Per firm mark-up	1.122	1.1	1.122	1.375	1.122	1.126	1.123	1.122	1.122	1.123

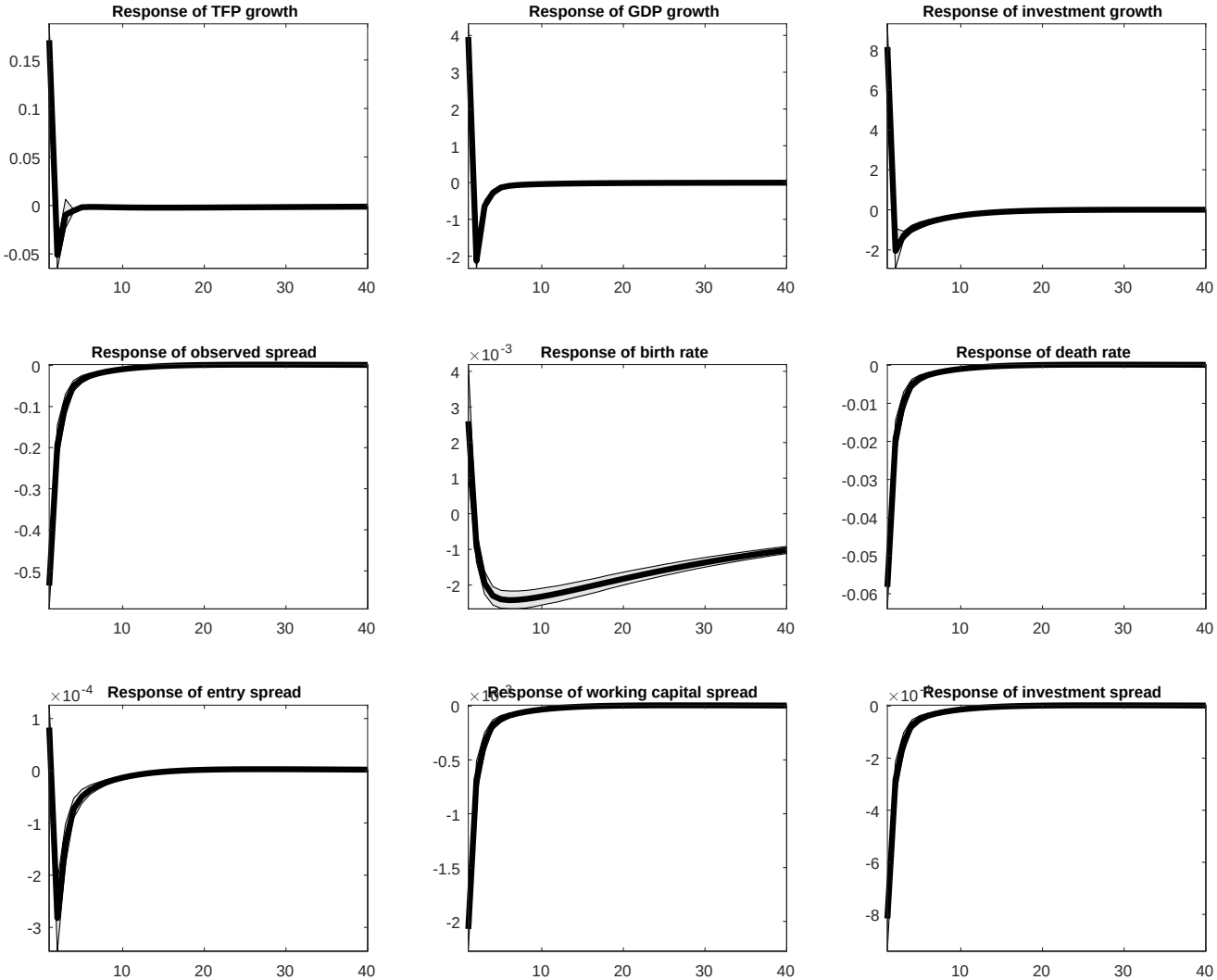
Wedge analysis

- Introduce "shocks" into model
  - TFP, entry costs ($f_{E,t}$), exogenous death rate, micro-uncertainty about entrepreneur and firm productivity (common), discount rate, labor wedge (supply), and marginal efficiency of investment
  - independent, AR(1) processes.
- Estimate shock process using Bayesian methods
  - observables: same as mixed frequency VAR
  - observable spread = weighted average of the three model spreads
  - quarterly data: 1981:1-2019:4
  - allow for missing observations

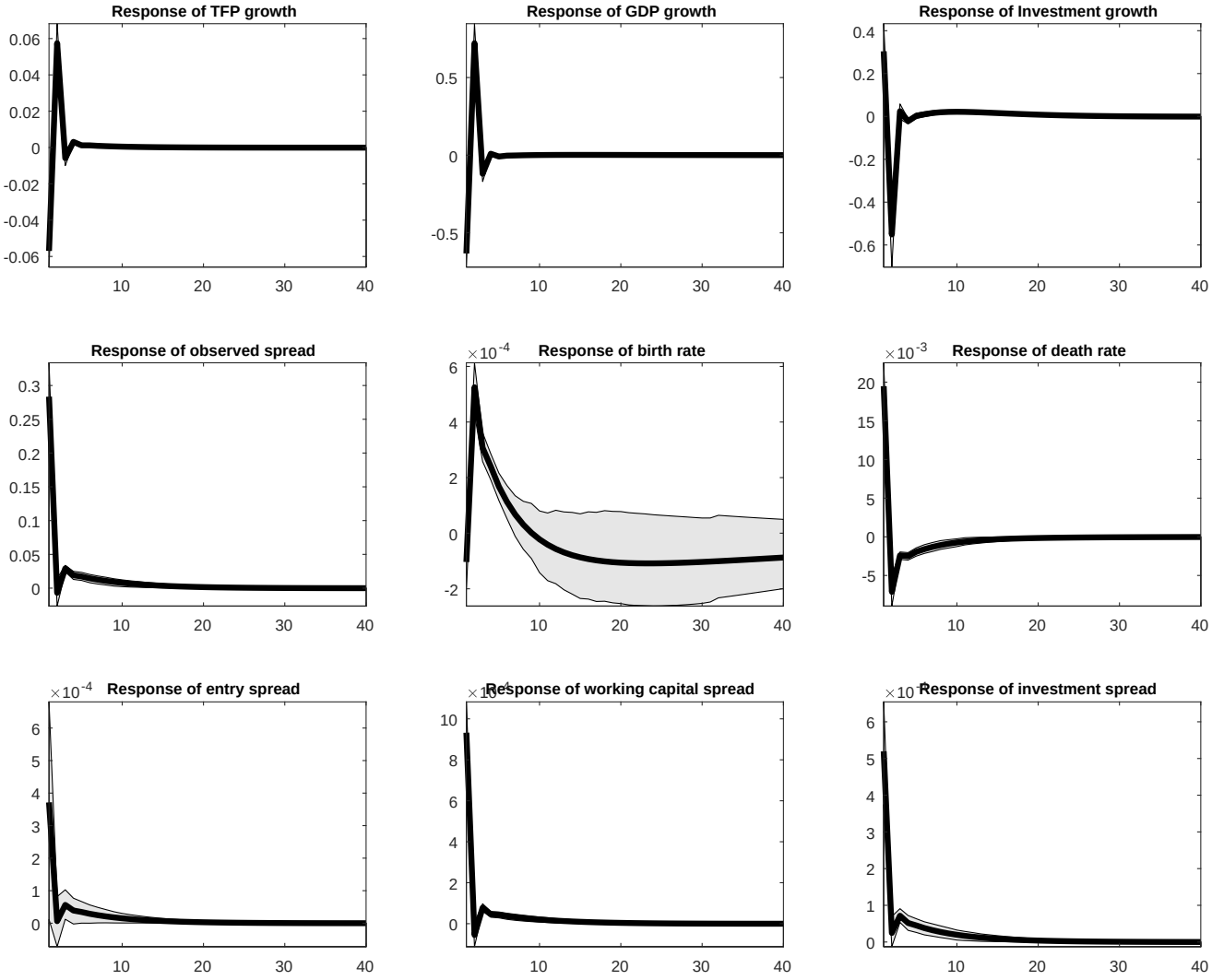
Impulse responses

- Shock to discount factor (increase): Figure 4
  - persistent decrease in spreads (except entry)
  - inceases in TFP, GDP, Investment growth
- Shock to micro-uncertainty: Figure 5
  - spreads rise
  - deaths rise, birth fall on impact (complicated dynamics)
  - TFP, GDP, Investment growth mixed ("zig-zags")
- Shock to TFP: Figure 6
  - TFP, GDP, Investment growth increases
  - Births rise
  - Spreads mixed response ("zig-zag")

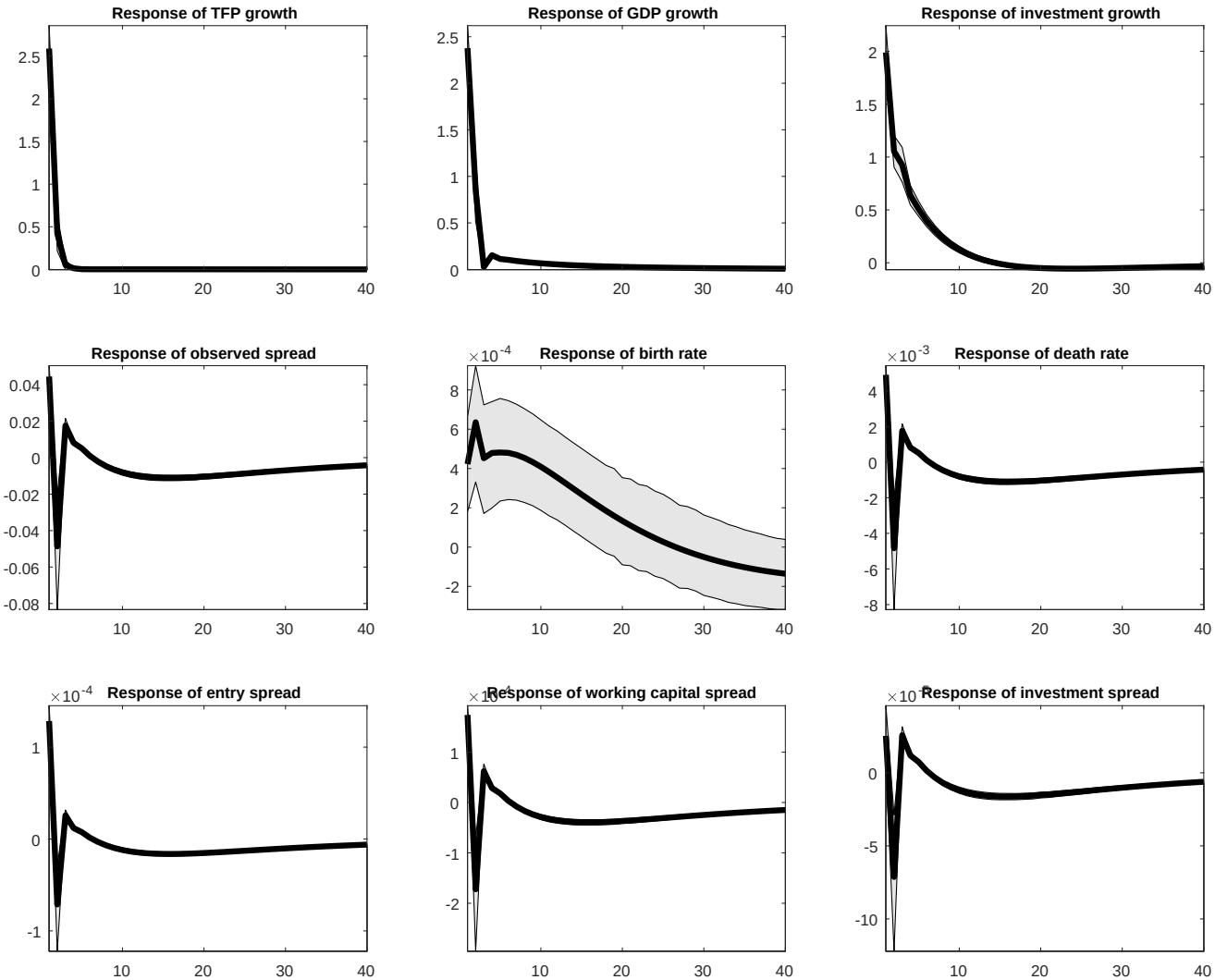
Structural model impulse responses: discount factor shock



Structural model: micro-uncertainty shock



Structural model impulse responses: TFP shock



Model correlations: Table 5

- Spread:
  - negative correlation with TFP, GDP, investment growth
  - very weak correlation with birth rate
  - too strong correlation with death rate
- Birth rate:
  - model correlations too small
- Death rate:
  - correlations with economic activity not so bad
  - correlation with spread much too large

Model cross-correlations

Table 5. Contemporaneous Correlations Implied by the Model

	Correlation with Spread:		Correlation with Birth rate:		Correlation with Death rate:	
Variable	**Data**	**Baseline**	**Data**	**Baseline**	**Data**	**Baseline**
TFP growth	*−0.19*	−0.02	*0.10*	0.04	*−0.08*	−0.03
GDP growth	*−0.48*	−0.35	*0.37*	0.06	*−0.22*	−0.25
Investment growth	*−0.51*	−0.26	*0.31*	0.10	*−0.42*	−0.21
Spread	*1.00*	1.00	*−0.61*	0.03	*0.12*	0.68
Birth rate	*−0.61*	0.03	*1.00*	1.00	*0.34*	0.10
Death rate	*0.12*	0.68	*0.34*	0.10	*1.00*	1.00

Model correlations: Table 6

- Model spreads vs observed spread:
  - Working capital and investment spreads highly correlated with observed spread
  - entry spread much less so
- working capital and investment spreads
  - similar correlations with TFP, GDP, and investment
- entry spreads
  - substantial positive correlations with TFP, GDP, investment, and birth rates–counterfactual

Model cross-correlations

Table 6. Unobserved Spread Correlations from the Model

observable variable	Correlation with: Entry spread	Working capital spread	Investment spread	Micro-uncertainty
TFP growth	0.09	−0.01	−0.05	−0.00
GDP growth	0.25	−0.38	−0.35	−0.01
Investment growth	0.47	−0.33	−0.20	−0.01
Spread	0.39	0.99	0.96	0.26
Birth rate	0.30	0.01	−0.02	0.00
Death rate	0.16	0.72	0.55	0.03
Entry spread	1.00	0.31	0.35	0.24
Work Cap. spread		1.00	0.93	0.22
Invest. spread			1.00	0.32

Model: Summary

- Model missing the mark on entry:
  - entry spread driven by demand for entry services
  - entry relies on fluctuations in exogenous entry costs
- Death rate too correlated with working capital defaults:
  - fluctuations in discount factor important for spread, GDP, investment, deaths
    - role for monetary policy (?)

Possible directions for future work

- Quantitative analysis
  - Drop TFP dispersion measure
    - Doesn't seem to add much to atheoretical or model empirics
  - better measurement of extent of credit frictions
    - spread on entry – (venture capital ?)
    - spread on working capital (lines of credit?)

Possible directions for future work

- Model features:
  - Add non-default endogenous exit
  - New Keynesian nominal frictions
  - News shocks