EARNINGS-BASED BORROWING CONSTRAINTS AND PECUNIARY EXTERNALITIES

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MOTIVATION

- US firms face two types of credit constraints: asset-based and earnings-based
  - Liquidation value of physical assets vs. borrower's current EBITDA limit debt access
  - Direct micro evidence: 80% of corporate debt is earnings-based (Lian and Ma, 2020)
  - Consequences for business cycle dynamics (Drechsel, 2020)

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  - Direct micro evidence: 80% of corporate debt is earnings-based (Lian and Ma, 2020)
  - Consequences for business cycle dynamics (Drechsel, 2020)

- Limited understanding of **normative implications** of earnings-based constraints
  - This paper provides a theoretical treatment
  - Structural model with (constrained) efficiency characterization
  - Implications for macroprudential policy

PREVIEW OF FINDINGS

- Asset-based constraint: firms **over-borrow** in decentralized equilibrium
  - Echoes existing insights of the literature, e.g. Dávila and Korinek (2018)
  - Higher asset price relaxes constraint $\rightarrow$ not internalized
- Earnings-based constraint: firms **under-borrow** in decentralized equilibrium
  - Higher input price (wage) tightens constraint $\rightarrow$ not internalized
- Interest coverage constraint: 'mixture' of earnings- and asset-based constraint

PREVIEW OF INTUITION

- Borrowing today reduces borrower's net worth tomorrow (all else equal)
- Suppose the fact borrower net worth is lower tomorrow . . .
  - . . . lowers the price of physical capital
  - . . . lowers wages

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- Lower price of physical capital tomorrow makes asset-based constraint tighter
  - Not internalized by asset-based borrower today $\rightarrow$ borrows "too much"

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  - . . . lowers the price of physical capital
  - . . . lowers wages
- Lower price of physical capital tomorrow makes asset-based constraint tighter
  - Not internalized by asset-based borrower today $\rightarrow$ borrows "too much"
- Lower wage tomorrow makes earnings-based constraint looser
  - Not internalized by earnings-based borrower today $\rightarrow$ borrows "too little"

PREVIEW OF EXTENSIONS

- Working capital
- Wage rigidity
- Small open economy
- Output vs. input prices

RELATED LITERATURE

- **Pecuniary externalities with financial frictions:**

  Lorenzoni (2008), Bianchi (2011), Benigno, Chen, Otrok, Rebucci, and Young (2013), Bianchi (2016), Dávila and Korinek (2018), Ottonello, Perez, and Varraso (2019),...

  - **Variety of credit constraints → subtleties in their policy implications**

- **Aggregate demand externalities:**

  Farhi and Werning (2016), Korinek and Simsek (2016), Schmitt-Grohé and Uribe (2016)

  - **Pecuniary externalities working through input prices in financial constraints**

- **Empirical background of credit constraints:**

  Lian and Ma (2020), Drechsel (2020), Greenwald (2019),...

  - **Normative implications of asset-based and earnings-based constraints**

PLAN FOR REST OF THE TALK

1. Main intuition
2. Empirical evidence
3. The model
   A. Setting
   B. Efficiency analysis
   C. Model restrictions and main results
4. Extensions and discussion
5. Conclusion

MAIN INTUITION

MAIN INTUITION

- Consider a generic financial constraint:

$$\Phi(x', \boldsymbol{z}, \widetilde{\boldsymbol{z}}) \geq 0$$

  - x': financial asset position ($x' < 0$: borrowing)
  - $\boldsymbol{z}$: endogenous variables chosen by the agent
  - $\widetilde{\boldsymbol{z}}$: endogenous or exogenous variables taken as given by the agent (e.g., prices)

- Source of inefficiency:
  - Agents do not internalize that their choices move (future) prices in $\widetilde{\boldsymbol{z}}$
    $\rightarrow$ pecuniary externality

MAIN INTUITION

- The **direction** of how choices (x') move prices ($\widetilde{z}$), and therefore the constraint (Φ) matters for the normative implications
- There are financial constraints in which prices other than that of collateral enter
- Those prices may have the opposite effect on credit constraints

MAIN INTUITION: ASSET-BASED CONSTRAINT

- Asset-based collateral constraint:
  - $\boldsymbol{z} = k'$, $\widetilde{\boldsymbol{z}} = q$, and $\Phi(x', \boldsymbol{z}, \widetilde{\boldsymbol{z}}) = x' + \phi q k' \geq 0 \Rightarrow -x' \leq \phi q k'$
  - $q = q(X, K)$: market price of capital as a function of the aggregate state variables
  - Aggregate states are net worth and capital

- Suppose q depends positively on aggregate borrower net worth X
  - If more borrowing today:
    $\Rightarrow$ Future aggregate borrower net worth $\downarrow$
    $\Rightarrow$ Future price of capital $\downarrow$
    $\Rightarrow$ Tightening of future borrowing limit

- Agents do not internalize this effect, **over-borrow** relative to the social optimum

MAIN INTUITION: EARNINGS-BASED CONSTRAINT

- Earnings-based constraint:
  - $\boldsymbol{z} = [y, \ell]$, $\widetilde{\boldsymbol{z}} = w$, and $\Phi(x', \boldsymbol{z}, \widetilde{\boldsymbol{z}}) = x' + \widetilde{\phi}(y - w\ell) \geq 0 \Rightarrow -x' \leq \widetilde{\phi}(y - w\ell)$
  - $w = w(X, K)$: market wage as a function of the aggregate state variables

- Suppose w increases with aggregate borrower net worth $X \ldots$
  - If more borrowing today:
    $\Rightarrow$ Future aggregate borrower net worth $\downarrow$
    $\Rightarrow$ Future wage $\downarrow$
    $\Rightarrow$ Loosening of future borrowing limit

- Agents do not internalize this effect, **under-borrow** relative to the social optimum

EMPIRICAL EVIDENCE

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- Mounting microeconomic evidence in favor of $-x' \leq \widetilde{\phi}(y - w\ell)$
- Earnings-based borrowing constraints can arise through:
  - Debt covenants: legal provisions in loan contracts
  - Credit ratings, bankruptcy procedures, ...
- Lian and Ma (2020): 80% of corporate debt earnings-based
- Drechsel (2020): earnings-based constraints matter for business cycle dynamics
- Caglio, Darst, and Kalemli-Özcan (2021) shows that earnings-based are prevalent for private small and medium-sized companies (SMEs)

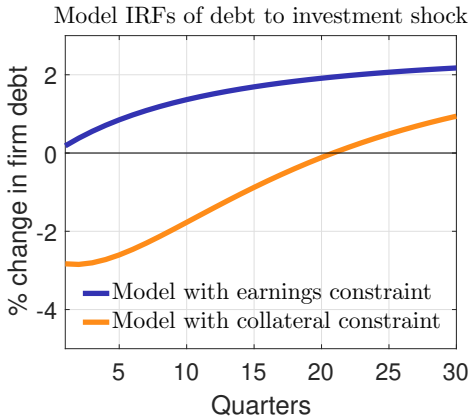
EMPIRICAL EVIDENCE: LOAN COVENANTS

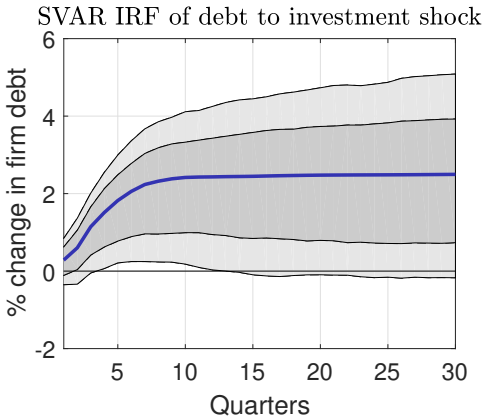
	Covenant type	Median	Mean	Freq. (%)
1	Max Debt to EBITDA	3.75	4.60	60.5
2	Min EBITDA to Interest	2.50	2.56	46.7
3	Min EBITDA to Fixed Charge	1.25	1.42	22.1
4	Max. Leverage ratio	0.60	0.64	21.3
5	Max. Capex	20M	194M	15.1
6	Net Worth	126M	3.2B	11.5

EBITDA is *earnings before interest, taxes, depreciation and amortization*

- Covenants based on earnings very prevalent
- Covenants bind frequently with large economic effects (see e.g. Chodorow-Reich and Falato, 2021)

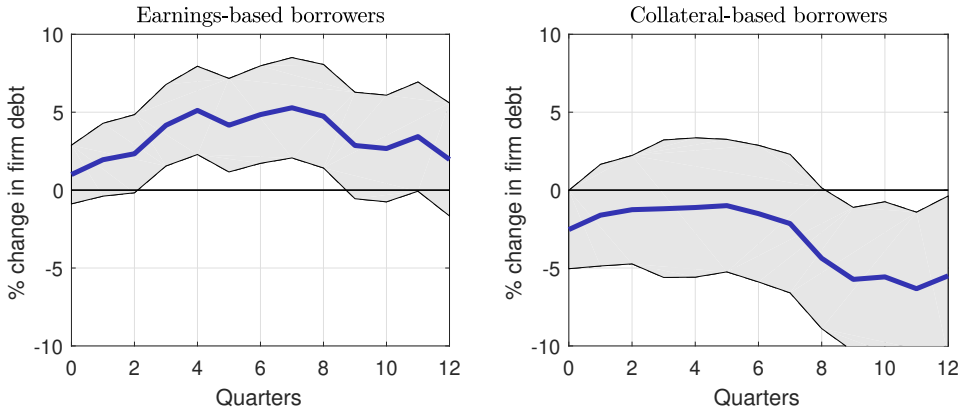
BUSINESS CYCLE CONSEQUENCES (DRECHSEL, 2020)





- Aggregate debt response consistent with earnings-based constraint, not with collateral constraint

BUSINESS CYCLE CONSEQUENCES (DRECHSEL, 2020)



- Split of debt response across borrower types consistent with model prediction across alternative constraints

THE LITERATURE IN ONE TABLE

Study	Asset-based	Earnings-based	
		Debt-to-Earnings	Interest coverage
Lian and Ma (2020)	Prevalence: 20%		Prevalence: 80%
	(classification procedure; several data sources, including hand-collected data)		
	Strong sensitivity of corporate borrowing to changes in EBITDA; low sensitivity of corporate borrowing to changes in real estate values (regression analysis, natural experiment based on accounting rule change)		
	Financial amplification (fire sale) effects	Financial amplification dynamics mitigated	
	(Structural model)		
Drechsel (2020)		$> 61\%$ of loan debt has earnings-related covenants	
		(Dealscan)	
	Model response of debt to investment shocks $\neq$ empirical response	Model response of debt to investment shocks $=$ empirical response	
	(Structural model, macro data, Compustat-Dealscan)		
	Markups countercyclical	Markups procyclical	
	(New Keynesian model, macro data)		
Greenwald (2019)		Most firms with interest coverage covenants	$> 80\%$ of firms which have any loan covenants
		(Compustat-Dealscan)	
	Weak response to monetary policy	Weak response to monetary policy	Strong response to monetary policy
	State dependence based on level of interest rats		
	(Structural model, Compustat-Dealscan)		

THE MODEL

SETTING

- Build on structure Dávila and Korinek (2018) + labor market
- Three period model ($t = 0, 1, 2$)
- The state of nature, $\theta \in \Omega$, is revealed at date 1
- Two types of agents: borrowers (b) and lenders (l)
- Both agents produce, consume and supply labor
- Borrowers face credit constraints

AGENTS' PROBLEM

- Agent $i \in \{b, l\}$ maximizes

$$U^i = \mathbb{E}_0 \left[\sum_{t=0}^{2} \beta^t u^i(c_t^i, \ell_{st}^i) \right]$$

subject to budget constraints

$$c_0^i + h^i(k_1^i) + \int_{\theta \in \Theta} m_1^\theta x_1^{i,\theta} d\theta = e_0^i$$

$$c_1^{i,\theta} + q^\theta \Delta k_2^{i,\theta} + m_2^\theta x_2^{i,\theta} = e_1^{i,\theta} + x_1^{i,\theta} + F^i(k_1^i, \ell_{d1}^{i,\theta}) - w_1^\theta \ell_{d1}^{i,\theta} + w_1^\theta \ell_{s1}^{i,\theta}, \quad \forall \theta$$

$$c_2^{i,\theta} = e_2^{i,\theta} + x_2^{i,\theta} + F^i(k_2^{i,\theta}, \ell_{d2}^{i,\theta}) - w_2^\theta \ell_{d2}^{i,\theta} + w_2^\theta \ell_{s2}^{i,\theta}, \quad \forall \theta$$

and financial constraints

$$\Phi_1^b(x_1^b, k_1^b) \geq 0$$

$$\Phi_2^{b,\theta}(x_2^{b,\theta}, k_1^b, k_2^{b,\theta}, \{\ell_{dt}^{b,\theta}, \ell_{st}^{b,\theta}\}_{t=1}^2; q^\theta, w_1^\theta, w_2^\theta, m_2^\theta) \geq 0, \ \forall \theta$$

FINANCIAL CONSTRAINT

- Main constraint of interest: period-1 financial constraint

$$\Phi_2^{b,\theta}(x_2^{b,\theta}, k_1^b, k_2^{b,\theta}, \{\ell_{dt}^{b,\theta}, \ell_{st}^{b,\theta}\}_{t=1}^2; q^\theta, w_1^\theta, w_2^\theta, m_2^\theta) \geq 0, \ \forall\theta$$

- General formulation in which all model variables can enter
- Includes:
  - Asset-based constraint: $-x_2^{b,\theta} \leq \phi q^\theta k_2^{b,\theta}$
  - Earnings-based constraint: $-x_2^{b,\theta} \leq \widetilde{\phi}(F^b(k_1^b, \ell_{d1}^{b,\theta}) - w_1^\theta \ell_{d1}^{b,\theta})$
  - Interest coverage constraint: $-x_2^{b,\theta} \leq \hat{\phi}\frac{F^b(k_2^{b,\theta}, \ell_{d2}^{b,\theta}) - w_2^\theta \ell_{d2}^{b,\theta}}{i_2^\theta}$

- Decentralized equilibrium (backward induction)
  - Date 2: purely intra-temporal consumption, labor supply and demand
  - Date 1: express welfare as a function of state variables

$$V^{i,\theta}(n_1^{i,\theta}, k_1^i; N_1^\theta, K_1) = \max_{\{c_1^{i,\theta}, c_2^{i,\theta}, k_2^{i,\theta}, x_2^{i,\theta}, \ell_{dt}^{i,\theta}, \ell_{st}^{i,\theta}\}} \left\{ u^i(c_1^{i,\theta}, \ell_{s1}^{i,\theta}) + \beta u^i(c_2^{i,\theta}, \ell_{s2}^{i,\theta}) \right\}$$

s.t. period 1 and 2 budget constraint and period 1 financial constraint

- net worth: $n_1^{i,\theta} \equiv e_1^{i,\theta} + x_1^{i,\theta}$
- Prices are functions of only aggregate states
- In equilibrium, $n_1^{i,\theta} = N_1^{i,\theta}$, $k_1^i = K_1^i$

- Following Dávila and Korinek (2018), "sufficient statistics" approach
- The effect of changes in $N_1^{j,\theta}$ on $V^{i,\theta}$:

$$V_{N_1^j}^{i,\theta} \equiv \frac{dV^{i,\theta}(\cdot)}{dN_1^{j,\theta}} = \lambda_1^{i,\theta}\mathcal{D}_{1N^j}^{i,\theta} + \lambda_2^{i,\theta}\mathcal{D}_{2N^j}^{i,\theta} + \kappa_2^{i,\theta}\mathcal{C}_{N^j}^{i,\theta}$$

  - Welfare changes that are not internalized by the agents, work through prices
  - Distinguish between distributive effects ($\mathcal{D}$) and constraint effects ($\mathcal{C}$)

$$V_{N_1^j}^{i,\theta} \equiv \frac{dV^{i,\theta}(\cdot)}{dN_1^{j,\theta}} = \lambda_1^{i,\theta}\mathcal{D}_{1N^j}^{i,\theta} + \lambda_2^{i,\theta}\mathcal{D}_{2N^j}^{i,\theta} + \kappa_2^{i,\theta}\mathcal{C}_{N^j}^{i,\theta}$$

- **Distributive effects:**
  - Changes in prices that benefit one agent, and make other agent worse off
  - Zero-sum
  - Not our focus

$$V^{i,\theta}_{N^j_1} \equiv \frac{dV^{i,\theta}(\cdot)}{dN^{j,\theta}_1} = \lambda^{i,\theta}_1 \mathcal{D}^{i,\theta}_{1N^j} + \lambda^{i,\theta}_2 \mathcal{D}^{i,\theta}_{2N^j} + \kappa^{i,\theta}_2 \mathcal{C}^{i,\theta}_{N^j}$$

- **Constraint effects:** changes in prices that affect tightness of credit constraints

$$\mathcal{C}^{b,\theta}_{N^j} \equiv \frac{\partial \Phi^{b,\theta}_2}{\partial q^\theta} \frac{\partial q^\theta}{\partial N^{j,\theta}_1} + \frac{\partial \Phi^{b,\theta}_2}{\partial m^\theta_2} \frac{\partial m^\theta_2}{\partial N^{j,\theta}_1} + \frac{\partial \Phi^{b,\theta}_2}{\partial w^\theta_1} \frac{\partial w^\theta_1}{\partial N^{j,\theta}_1} + \frac{\partial \Phi^{b,\theta}_2}{\partial w^\theta_2} \frac{\partial w^\theta_2}{\partial N^{j,\theta}_1}$$

$$\mathcal{C}^{l,\theta}_{N^j} = 0$$

($\kappa^{i,\theta}_2$ is Lagrange multiplier on the financial constraint)

OTHER EFFECTS

- In the same vein, can study effects coming from $\frac{dV^{i,\theta}(\cdot)}{d\boldsymbol{K}_{\mathbf{1}}^{\boldsymbol{j},\boldsymbol{\theta}}}$
- We focus on over-/under-borrowing rather than over-/under-investing
- Bound by "anything goes" result of Dávila and Korinek (2018)

EFFICIENCY ANALYSIS

CONSTRAINED EFFICIENT ALLOCATION

- Planner internalizes distributive and constraint effects of borrowing decision
- Chooses allocations in $t = 0$ subject to:
  1. The same $t = 0$ constraints as the private agents
  2. The optimal behavior of private agents in periods $t = 1, 2$
- Corresponds to problem of constrained Ramsey planner who can levy $t = 0$ taxes

SOCIAL PLANNER PROBLEM

$$\max \sum_i \alpha^i \{u^i(C_0^i) + \beta \mathbb{E}_0[V^{i,\theta}(N_1^{i,\theta}, K_1^i; N^\theta, K_1)]\}$$

subject to $t = 0$ resource and credit constraints

$$\sum_i [C_0^i + h^i(K_1^i) - e_0^i] \leq 0$$

$$\sum_i X_1^{i,\theta} = 0, \ \ \forall \theta$$

$$\Phi_1^i(X_1^i, K_1^i) \geq 0, \ \forall i$$

- **Proposition:** A decentralized equilibrium with the following corrective taxes replicates the constrained efficient allocation

$$\tau_x^{i,\theta} = -\Delta MRS_{01}^{ij,\theta}\mathcal{D}_{1N^i}^{i,\theta} - \Delta MRS_{02}^{ij,\theta}\mathcal{D}_{2N^i}^{i,\theta} - \tilde{\kappa}_2^{b,\theta}\mathcal{C}_{N^i}^{b,\theta},\ \forall i,\theta$$

  - $\tau_x^{i,\theta} > 0$: taxes on saving $\Rightarrow$ under-borrowing in decentralized equilibrium
  - $\Delta MRS_{0t}^{ij,\theta} \equiv MRS_{0t}^{i,\theta} - MRS_{0t}^{j,\theta}$
  - $\tilde{\kappa}_2^{b,\theta}$: shadow price on credit constraint

HOW TO PROCEED WITH EFFICIENCY ANALYSIS

- For specific financial constraints $\Phi_2^{b,\theta}$, find $\mathcal{C}_{N^i}^{b,\theta}$
- Given sign of $\mathcal{C}_{N^i}^{b,\theta}$, determine sign of $\tau_x^{i,\theta}$
  - If $\tau_x^{i,\theta} < 0$: planner corrects 'over-borrowing'
  - If $\tau_x^{i,\theta} > 0$: planner corrects 'under-borrowing'
- For first step, need to specialize model further

ADDITIONAL MODEL RESTRICTIONS AND MAIN RESULTS

- **Condition for collateral constraints:**

$$\frac{\partial q^{\theta}}{\partial N_1^{i,\theta}} \geq 0, \ \forall i$$

- **Argument:**
  - Capital supply is fixed
    $\Rightarrow$ an increase in resources will increase the demand for capital
    $\Rightarrow$ upward pressure on capital price

- **Condition for earnings-based constraints:**

$$\frac{\partial w_1^\theta}{\partial N_1^{i,\theta}} \geq 0, \ \forall i$$

- **Argument:**
  - Higher net worth loosens credit constraint
    $\Rightarrow$ Effective cost of hiring labor $\downarrow$, so **labor demand increases**
  - Higher net worth increases consumption
    $\Rightarrow$ (Under standard preference) Demand for leisure $\uparrow$, so **labor supply decreases**

- **Condition for interest coverage constraints:**

$$\frac{\partial m_2^\theta}{\partial N_1^{i,\theta}} \geq 0, \ \forall i$$

$$\frac{\partial w_2^\theta}{\partial N_1^{i,\theta}} \geq 0, \ \forall i$$

- **Argument:**
  - Higher net worth increases incentive to save more to smooth consumption
    $\Rightarrow$ Price of debt (= inverse of interest rate) increase (tends to move in the same way with the price of capital due to no-arbitrage restriction)
  - Direct analogy to the argument for the period 1 wage

- **Collateral constraint:**

$$\Phi_2^{b,\theta}(\cdot) = x_2^{b,\theta} + \phi q^\theta k_2^{b,\theta} \geq 0$$

- **Proposition:** There is an **over-borrowing** effect through constraint externalities
- **Proof:**
  - $-\tilde{\kappa}_2^{b,\theta} \mathcal{C}_{N^i}^{b,\theta} = -\tilde{\kappa}_2^{b,\theta} \frac{\partial \Phi_2^{b,\theta}}{\partial q^\theta} \frac{\partial q^\theta}{\partial N_1^{i,\theta}} \leq 0 \Rightarrow$ subsidize saving (= penalize borrowing)

- **Earnings-based constraint:**

$$\Phi_2^{b,\theta}(\cdot) = x_2^{b,\theta} + \widetilde{\phi}(F^b(k_1^b, \ell_{d1}^{b,\theta}) - w_1^\theta \ell_{d1}^{b,\theta}) \geq 0$$

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- **Interest coverage constraint:**

$$\Phi_2^{b,\theta}(\cdot) = x_2^{b,\theta} + \hat{\phi}\frac{F^b(k_2^{b,\theta}, \ell_{d2}^{b,\theta}) - w_2^\theta \ell_{d2}^{b,\theta}}{i_2^\theta} \geq 0$$

- **Proposition:** There is an **ambiguous** effect through constraint externalities
- **Proof:**
  - $-\tilde{\kappa}_2^{b,\theta}\mathcal{C}_{N^i}^{b,\theta} = -\tilde{\kappa}_2^{b,\theta}(\frac{\partial \Phi_2^{b,\theta}}{\partial w_2^\theta}\frac{\partial w_2^\theta}{\partial N_1^{i,\theta}} + \frac{\partial \Phi_2^{b,\theta}}{\partial i_2^\theta}\frac{\partial i_2^\theta}{\partial N_1^{i,\theta}}) \lesseqgtr 0$
  - This constraint is "mixture" of earnings-based and asset-based constraint
  - Why? $1/i$ co-moves with q through no-arbitrage condition

SUMMARY OF FINDINGS

- Asset-based constraint: agents **over-borrow** in decentralized equilibrium
  - Echoes existing insights of the literature, e.g. Dávila and Korinek (2018)
  - Higher asset price relaxes constraint $\rightarrow$ not internalized
- Earnings-based constraint: agents **under-borrow** in decentralized equilibrium
  - Higher input price (wage) tightens constraint $\rightarrow$ not internalized
- Interest coverage constraint: 'mixture' of earnings- and asset-based constraint

EXTENSIONS

WORKING CAPITAL

- Several authors propose models with working capital and collateral constraints
  - See e.g. Bianchi and Mendoza (2010), Jermann and Quadrini (2012), Bianchi (2016)
- Suppose wage bill financed with an intraperiod loan $x_{wc} = -\psi w\ell$

$$-(x' - \psi w\ell) \leq \widetilde{\phi}(F(k,\ell) - w\ell) \Rightarrow -x' \leq -(\widetilde{\phi}F(k,\ell) - (\widetilde{\phi} + \psi)w\ell)$$

- $\widetilde{\phi} + \psi > \widetilde{\phi}$: more pronounced under-borrowing effect

STICKY WAGES

- Sticky wage rule: $w = \chi w^* + (1-\chi)w_{-1}, 0 < \chi < 1$
  - w^*: flexible component, w_{-1}: previous period's wage

$$-x' \leq \widetilde{\phi}(F(k,\ell) - w\ell) \Rightarrow -x' \leq -(\widetilde{\phi}F(k,\ell) - \widetilde{\phi}\chi)w^*\ell - \widetilde{\phi}(1-\chi)w_{-1}\ell$$

- $\widetilde{\phi}\chi < \widetilde{\phi}$: less pronounced under-borrowing effect
- Good sense of the wage determination process matters for macroprudential policy

SMALL OPEN ECONOMY

- Several papers on welfare consequences of borrowing constraints in small open economies (see e.g. Bianchi, 2011)
- We focus on an endogenous interest rate because the background on earnings-based constraints is largely provided for the U.S.
- Microeconomic evidence on the specific forms of constraints is thinner for emerging economies, but would be very welcome
- Note that a fixed interest rates would make interest coverage constraint inherit the consequences of the earnings-based constraint (no 'mixture' result)

OUTPUT VS. INPUT PRICES

- In our real model, w denotes relative price
- But what if final goods price is not equal to 1?
- Need multi-good environment to think about meaningful output price variation
  1. Monopolistically competitive firms environment
     - Prices are choice variables, so firms internalize how price affects the constraint
     - However, firms would not internalize how their individual choices affect aggregate inflation, which could affect nominal debt limits
  2. Perfectly competitive firms environment
     - Effects on relative prices between different goods not internalized? (Fazio (2021))

CONCLUSION

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- Whether debt is backed by collateral or linked to firms' earnings has sharply different implications for macroprudential policy
- The pecuniary externality through wages in earnings-based constraints prescribes that a regulatory authority should, if anything, encourage firms to borrow
- Our analysis highlights the importance of a proper understanding of the microeconomic details behind which constraints matter in which markets
  - Asset-based borrowing: mortgage markets, repo markets, ...
  - Earnings-based borrowing: corporate credit markets

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