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)

- Limited understanding of **normative implications** of earnings-based constraints
  - This paper provides a theoretical treatment
  - Structural model with formal welfare characterization
  - Implications for optimal 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
  - Depending on labor market structure, can also lead to constrained efficiency

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),...
  - **Subtleties in the policy implications of different types of credit constraints**

- **Insights on the specific nature of credit constraints:**
  Lian and Ma (2020), Drechsel (2020), Greenwald (2019),...
  - **Normative implications of asset-based and earnings-based constraints**

PLAN FOR THE TALK

1. Main intuition
2. Empirical evidence
3. The model
   A. Setting
   B. Efficiency analysis
   C. Model restrictions and main results
4. Extensions
   - Working capital, open economy, input vs. output prices
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)

- Agents' choices move prices in $\widetilde{\boldsymbol{z}} \rightarrow$ pecuniary externality

- The direction of price changes matters for normative implications

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 net worth
  - If more borrowing today:
    $\Rightarrow$ Future aggregate borrower net worth $\downarrow$
    $\Rightarrow$ Future price of capital $\downarrow$ – *through lower demand for capital*
    $\Rightarrow$ 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 net worth
  - If more borrowing today:
    $\Rightarrow$ Future aggregate borrower net worth $\downarrow$
    $\Rightarrow$ Future wage $\downarrow$ – *through lower supply of labor*
    $\Rightarrow$ Loosening of future borrowing limit

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

EMPIRICAL EVIDENCE

EMPIRICAL EVIDENCE

- 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)

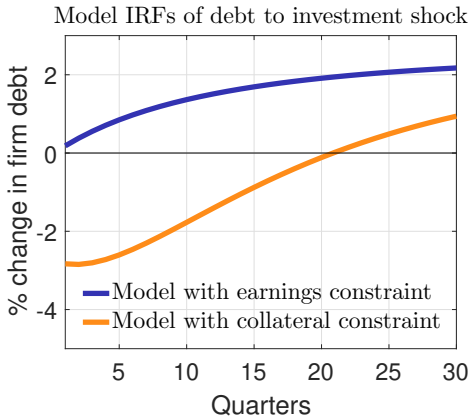
EMPIRICAL EVIDENCE (DRECHSEL, 2020)

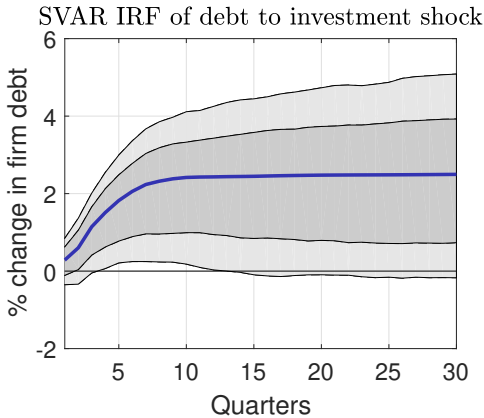
	Covenant type	Median	Mean	Freq. (%)
1	Max Debt to EBITDA	3.75	4.60	60.5
2	Min EBITDA to Interest	2.50	2.56	46.7
3	Min EBITDA to Fixed Charge	1.25	1.42	22.1
4	Max. Leverage ratio	0.60	0.64	21.3
5	Max. Capex	20M	194M	15.1
6	Net Worth	126M	3.2B	11.5

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)

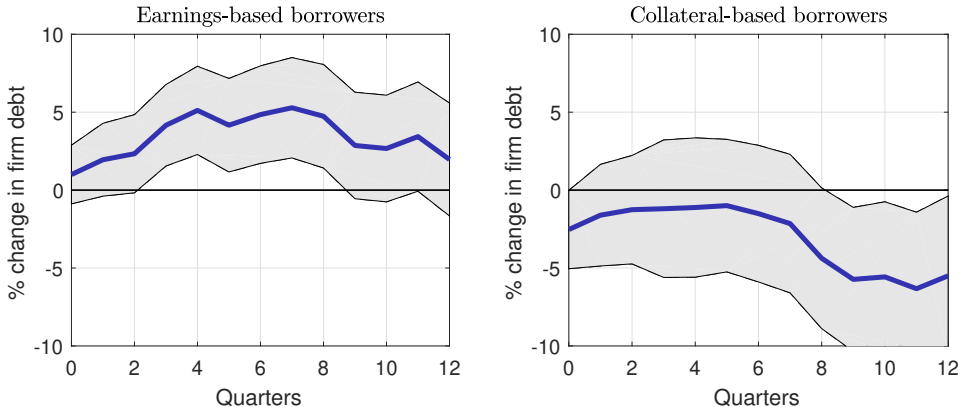
BUSINESS CYCLE CONSEQUENCES (DRECHSEL, 2020)





- 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 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: $-x_2^{b,\theta} \leq \hat{\phi}\frac{F^b(k_2^{b,\theta}, \ell_{d2}^{b,\theta}) - w_2^\theta \ell_{d2}^{b,\theta}}{i_2^\theta}$

SOLVING THE MODEL

- 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, make other agent worse off
  - 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

Details

- **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'
- To pin down signs, need to specialize model further

ADDITIONAL MODEL RESTRICTIONS AND MAIN RESULTS

- **Condition for collateral constraints:**

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

- **Explanation:**
  - Supply of capital is predetermined
  - An increase in net worth raises 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:**
  - Demand for labor is pinned down conditional on capital
  - Higher net worth increases consumption $\Rightarrow$ (under standard preference) demand for leisure $\uparrow$, so decrease in labor supply

    $\Rightarrow$ upward pressure on wage

- **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:**

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

- **Proposition:** There is an **under-borrowing** effect through constraint externalities
- **Proof:**
  - $-\tilde{\kappa}_2^{b,\theta} \mathcal{C}_{N^i}^{b,\theta} = -\tilde{\kappa}_2^{b,\theta} \frac{\partial \Phi_2^{b,\theta}}{\partial w_1^\theta} \frac{\partial w_1^\theta}{\partial N_1^{i,\theta}} \geq 0 \Rightarrow$ penalize saving (= subsidize borrowing)

- **Note:** if labor supply inelastic, $\partial w / \partial N$ term drops out $\Rightarrow$ **constrained efficiency**

- **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

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

CONCLUSION

- 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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APPENDIX SLIDES

FORMAL 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

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

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

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

Back