Pecuniary Externalities in Economies with Financial Frictions

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Motivation

Big picture: are financial crises associated with inefficiencies?

- wild changes in asset prices
- interaction and feedback with credit frictions

$\rightarrow$ suggests *pecuniary externalities* at work, i.e. externalities associated with price movements

- However, folk knowledge argues that pecuniary externalities do not matter for efficiency

BUT: this is no longer true in economies with financial frictions

This paper: characterize *optimal policies* with inefficient pecuniary externalities in economies with financial frictions

- general framework to focus on theoretical underpinnings

Summary

1. Characterize general efficiency properties of economies with financial frictions
2. Distinguish two *distinct* pecuniary externalities
   - distributive externalities (differing MRS)
   - collateral externalities (price in constraints)
3. Identify *sufficient statistics* for optimal corrective taxes on
   - Financing decisions
   - Investment decisions
4. Four applications that link sufficient statistics to primitives
   - externalities can generally take on either sign
   - illustrate which factors cause sign to flip

- Bonus: map existing literature into distributive & collateral externalities

Review of the (classic) literature

- Benchmark: Arrow Debreu with complete markets
  - First welfare theorem (FWT) applies
  - Standard proof of FWT not very intuitive
- Diamond 67: example of (constrained) efficiency with incomplete markets
  - *Efficiency of stock market equilibrium*
- Hart 75: example of inefficiency due to incomplete markets
  - Nonexistence of equilibrium
  - New market that makes everyone worse off
- Stiglitz 82: *inefficiency of stock market equilibrium*
  - With multiple goods, relative prices changes (i.e. pecuniary externalities) create inefficiency
- Geanakoplos-Polemarchakis 86: generic constrained inefficiency of GE with incomplete markets
- Greenwald-Stiglitz 86: generic constrained inefficiency of imperfect information/incomplete markets models

Environment

- Three dates: $t = 0, 1, 2$
- Uncertainty $\omega \in \Omega$, realized at date 1
- Two agents: borrowers and lenders $i = \{b, \ell\}$
- Utilities $U^i = \mathbb{E}_0 \left[\sum_{t=0}^{2} \beta^t u^i \left(c_t^i \right) \right]$ with $c_t^i \geq 0$
- Budget constraints

$$c_0^i + h^i \left(k_1^i \right) + \mathbb{E}_0 \left[m_1^\omega x_1^{i,\omega} \right] = e_0^i$$

$$c_1^{i,\omega} + q^\omega \Delta k_2^{i,\omega} + m_2^\omega x_2^{i,\omega} = e_1^{i,\omega} + x_1^{i,\omega} + F_1^{i,\omega} \left(k_1^i \right), \ \forall \omega$$

$$c_2^{i,\omega} = e_2^{i,\omega} + x_2^{i,\omega} + F_2^{i,\omega} \left(k_2^{i,\omega} \right), \ \forall \omega$$

- Interpretation of environment
  1. Firms/entrepreneurs
  2. Leveraged intermediaries
  3. Indebted households (homeowners)
  4. Financially constrained arbitrageurs

Financial constraints

- General specification of (vector) financial constraints on borrowers

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

$$\Phi_2^{b,\omega}\left(x_2^{b,\omega}, k_2^{b,\omega}; q^\omega\right) \geq 0, \ \forall \omega$$

- Interpretation of constraints
  1. Incomplete markets
  2. Limited commitment/enforcement of borrowers
  3. Limited commitment/enforcement of lenders
  4. Limited participation, etc
- Examples
  - $\Phi_1^b(\cdot) := \left(x_1^{b,\omega} - x_1^{b,\omega_0}\right)_{\omega \in \Omega \setminus \omega_0}$
  - $\Phi_2^{b,\omega}(\cdot) := x_2^{b,\omega} + \phi^\omega q^\omega k_2^{b,\omega} \geq 0$

Solving the model

First-Best: production efficiency + consumption efficiency

Decentralized equilibrium (backward induction):

- Date 2: trivial
- Date 1: express welfare as a function of state variables

$$V^{i,\omega}\left(n^{i,\omega}, k_1^i; N^\omega, K_1\right) = \max u^i\left(c_1^{i,\omega}\right) + \beta u^i\left(c_2^{i,\omega}\right)$$

  - $n^{i,\omega} = e_1^{i,\omega} + F_1^{i,\omega}\left(k_1^i\right) + x_1^{i,\omega}$ is individual net worth
  - k_1^i is individual capital holdings
  - $N^\omega = \left(N^{b,\omega}, N^{\ell,\omega}\right)$ and $K_1 = \left(K_1^b, K_1^\ell\right)$ are sector-wide net worth/capital holdings of both sectors
  - in equilibrium $n^{i,\omega} = N^{i,\omega}$ and $k_1^i = K_1^i$

Uninternalized Welfare Effects of $N^{i,\omega}$

Lemma: Individuals internalize the welfare effects of their own choices but not the welfare effects of aggregate choices:

$$V_{N^j}^{i,\omega} := \frac{\partial V^{i,\omega}(\cdot)}{\partial N^{j,\omega}} = \lambda_1^{i,\omega} \mathcal{D}_{N^j}^{i,\omega} + \kappa_2^{i,\omega} \mathcal{C}_{N^j}^{i,\omega}$$

which we can decompose into:

- **Distributive effects:** $N^{i,\omega}$ affects prices at which agents trade capital and bonds (and are zero-sum)

$$\mathcal{D}_{N^j}^{i,\omega} := -\frac{\partial q^\omega}{\partial N^{j,\omega}} \Delta K_2^{i,\omega} - \frac{\partial m_2^\omega}{\partial N^{j,\omega}} X_2^i$$

- **Collateral effects:** $N^{i,\omega}$ affects value of collateral

$$\mathcal{C}_{N^j}^{i,\omega} := \frac{\partial \Phi_2^{i,\omega}}{\partial q^\omega} \frac{\partial q^\omega}{\partial N^{j,\omega}}$$

similar for uninternalized welfare effects of aggregate capital K_1^i

Constrained Social Planner's Problem

- Constrained efficiency with ex-ante transfers

$$\max_{C_0^i, K_1^i, X_1^{i,\omega}} \sum_i \theta^i \left\{ u^i\left(C_0^i\right) + \beta \mathbb{E}_0 \left[V^{i,\omega}\left(N^{i,\omega}, K_1^i; N^\omega, K_1\right) \right] \right\}$$

$$\text{s.t.} \quad \sum_i \left[C_0^i + h^i\left(K_1^i\right) - e_0^i \right] \leq 0 \qquad (\nu_0)$$

$$\sum_i X_1^{i,\omega} = 0, \ \forall \omega \qquad (\nu_1^\omega)$$

$$\Phi_1^i\left(X_1^i, K_1^i\right) \geq 0 \qquad \left(\theta^i \kappa_1^i\right)$$

Proposition: Corrective Taxes

- **Corrective taxes**

$$\tau_x^{i,\omega} = -\Delta MRS^{ij,\omega}\mathcal{D}_{N^i}^{i,\omega} - \tilde{\kappa}_2^{b,\omega}\mathcal{C}_{N^i}^{b,\omega},\ \forall i,\omega$$
$$\tau_k^{i} = -\mathbb{E}_0\left[\Delta MRS^{ij,\omega}\mathcal{D}_{K^i}^{i,\omega}\right] - \mathbb{E}_0\left[\tilde{\kappa}_2^{b,\omega}\mathcal{C}_{K^i}^{b,\omega}\right],\ \forall i$$

  - Positive $\tau_x^{i,\omega}$: agent i should carry less wealth toward state ω
  - Positive τ_k^{i}: agent i should invest less in capital

- Examples of signs:
  - distributive externality: $\Delta K_2^{b,\omega} < 0$, $\frac{\partial q^\omega}{\partial N^{b,\omega}} > 0$, $\Delta MRS^{b\ell,\omega} > 0$
    $\Rightarrow \tau_x^{b,\omega} < 0$ – borrowers under-save (Lorenzoni '08)
  - collateral externality: $\tilde{\kappa}_2^{b,\omega} > 0$, $\frac{\partial \Phi_2^{b,\omega}}{\partial q^\omega} > 0$, $\frac{\partial q^\omega}{\partial N^{b,\omega}} > 0$
    $\Rightarrow \tau_x^{b,\omega} < 0$ – borrowers under-save (Jeanne-Korinek '10)

Proposition: Sufficient Statistics

- The sign and magnitude of **distributive externalities** are determined by the product of three variables:
  1. The difference in MRS of agents $\Delta MRS^{ij,\omega}$
  2. The net trading positions (net buying or net selling) on capital $\Delta K_2^{i,\omega}$ and financial assets X_2^i
  3. The sensitivity of equilibrium prices to changes in sector-wide state variables $\frac{\partial q^\omega}{\partial N^{j,\omega}}$, $\frac{\partial m_2^\omega}{\partial N^{j,\omega}}$, $\frac{\partial q^\omega}{\partial K_1^j}$, $\frac{\partial m_2^\omega}{\partial K_1^j}$
- The sign and magnitude of **collateral externalities** are determined by the product of three variables:
  1. The shadow value on the financial constraint $\tilde{\kappa}_2^{i,\omega}$
  2. The sensitivity of the financial constraint to the asset price $\frac{\partial \Phi_2^{i,\omega}}{\partial q^\omega}$
  3. The sensitivity of the equilibrium price of capital to changes in sector-wide state variables $\frac{\partial q^\omega}{\partial N^{j,\omega}}$, $\frac{\partial q^\omega}{\partial K_1^j}$

Corollaries 1, 2, 3

1. **Sign of externalities:**
   - Distributive externalities: anything goes
   - Collateral externalities: positive for well-behaved (unique) equilibria

2. **Externality pricing kernel**: the optimal corrective tax on agent i's holdings of a financial security Z is given by

$$\tau_Z^i = \mathbb{E}_0\left[\tau_x^{i,\omega} Z^\omega\right]$$

3. **Relationship between distortion in investment and financing decisions**: when $\frac{\partial q^\omega}{\partial K_1^i} = \frac{\partial m_2^\omega}{\partial K_1^i} = 0$, optimal taxes $\tau_x^{i,\omega}$ and τ_k^i satisfy

$$\tau_k^i = \mathbb{E}_0\left[\tau_x^{i,\omega} F_1^{i,\omega\prime}(\cdot)\right]$$

Corollaries 4, 5

- **4. Decoupling of fire sales, amplification and inefficiency:**
  - Amplification effects are captured by $\mathcal{D}^{i,\omega}_{N^i} > 0$ or $\mathcal{C}^{i,\omega}_{N^i} > 0$
  - Fire sales or amplification are neither necessary nor sufficient for constrained inefficiency

- **5. Three indeterminacy of implementation results:**
  - Allocation of financing wedge on borrowers versus lenders is indeterminate
  - Allocation of wedges on financing versus investment is indeterminate
    - if consumption is corner solution
    - or financing is corner solution

      $\rightarrow$ real allocations unaffected if taxes normalized to zero

      $\rightarrow$ zero taxes imply constrained efficiency

Four Applications

- Goal:
  - Link sufficient statistics to primitives
  - Illustrate plausible combinations

1. Efficient fire sales
2. Distributive externalities and the direction of capital trade
3. Distributive externalities and the sign of ΔMRS
4. Collateral externalities

Application 1

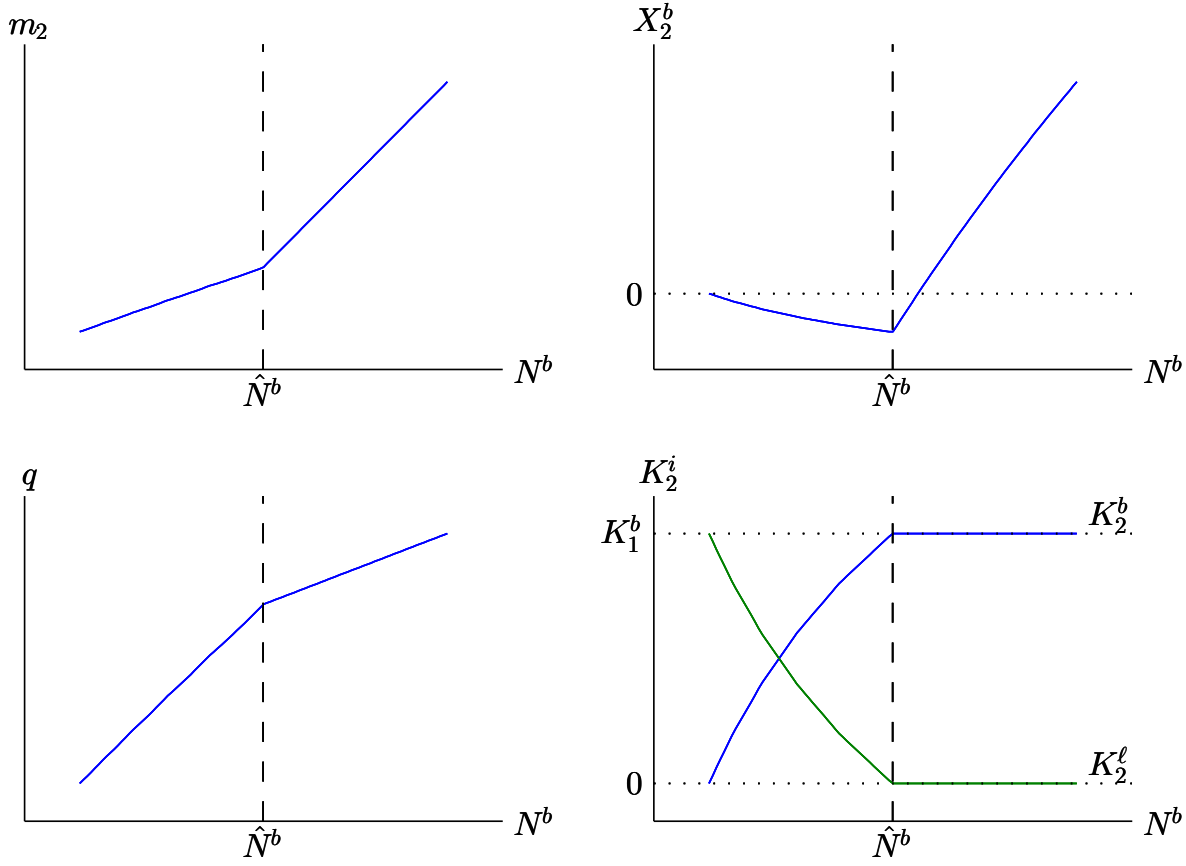

Figure: Date 1 Equilibrium

- Complete date 0 risk markets and distributive effects $\mathcal{D}$ only
- The decentralized equilibrium in the described economy is constrained efficient.

Application 2

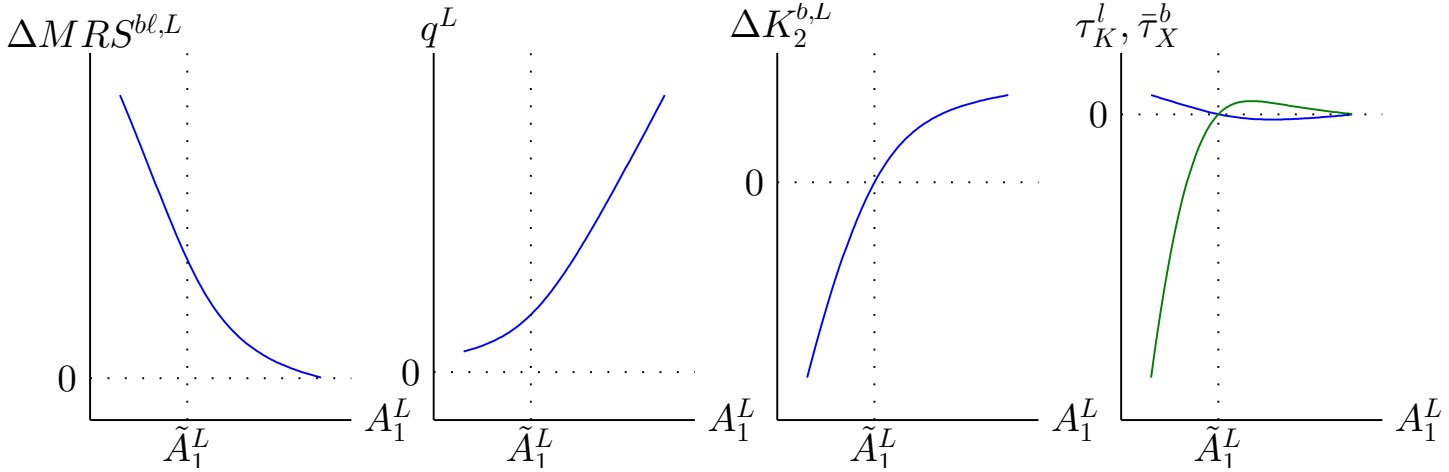

Figure: Components of Optimal Taxes $\bar{\tau}_x^b$, τ_k^ℓ in Application 2

- Risk-free bonds only in two-state economy $\omega \in \{L, H\}$
- Borrowers either buy or sell capital in constrained state L
- There is a threshold value $\tilde{A}_1^L$ s.t.
  - if $A_1^L < \tilde{A}_1^L$, the economy exhibits overborrowing by borrowers and overinvestment by lenders
  - if $A_1^L = \tilde{A}_1^L$, the economy is constrained efficient
  - if $A_1^L > \tilde{A}_1^L$, the economy exhibits underborrowing by borrowers and underinvestment by lenders

Application 3

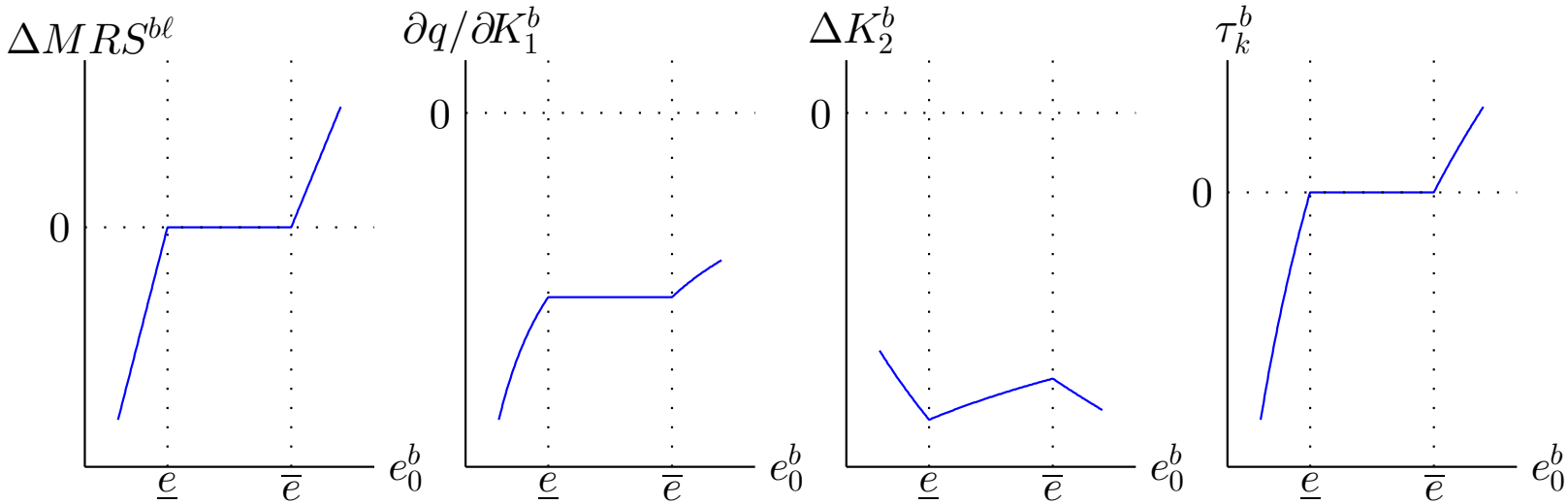

Figure: Components of Optimal Tax τ_k^b in Application 3

- Perfect foresight economy
- Borrowers are either constrained in borrowing or in saving
- There are two thresholds $\underline{e}$ and $\overline{e}$ for the value of $e_0^b - e_1^b$ s.t.
  - if $e_0^b - e_1^b < \underline{e}$, borrowers hit their date 0 borrowing limit, $\Delta MRS^{b\ell} > 0$, and the economy exhibits under-investment
  - if $\underline{e} \leq e_0^b - e_1^b \leq \overline{e}$, loose constraints & constrained efficiency
  - if $e_0^b - e_1^b > \overline{e}$, borrowers hit their date 0 saving limit, $\Delta MRS^{b\ell} < 0$, and the economy exhibits over-investment

Application 4

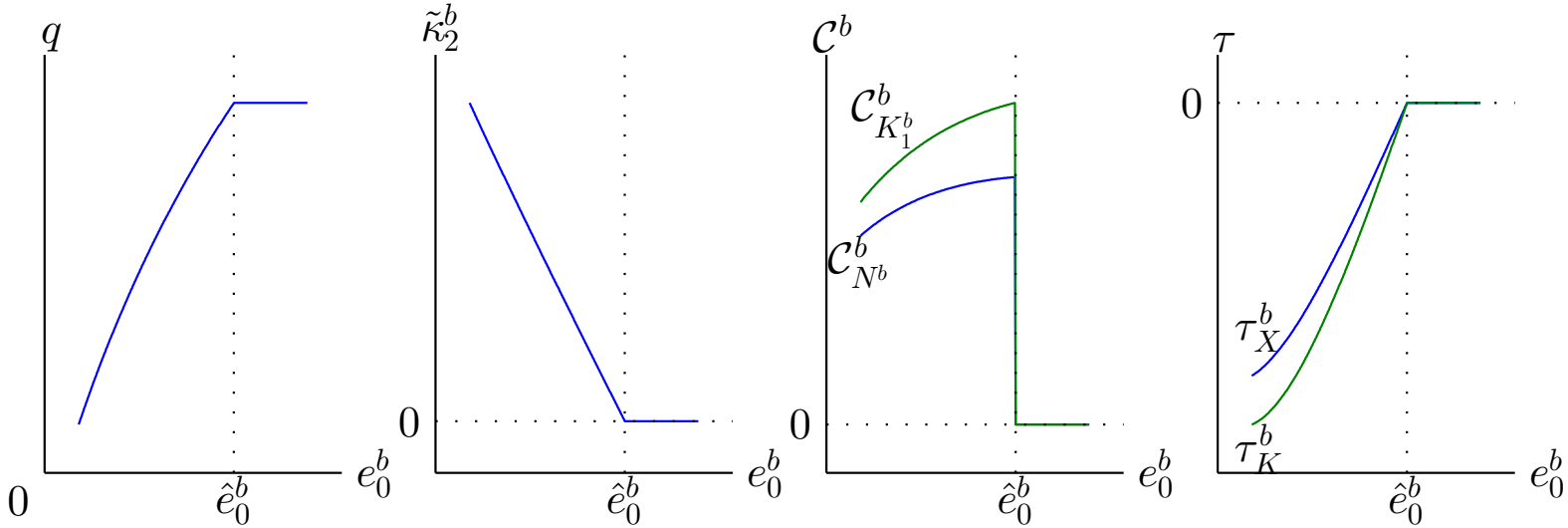

Figure: Components of Optimal Taxes τ_x^b, τ_k^b in Application 4

- Borrowers are subject to price dependent collateral constraint
- Overborrowing and underinvestment because of collateral externalities

Literature

- **Financial Amplification Effects:** Fisher (1933), Bernanke-Gertler (1990), Shleifer-Vishny (1992), Kiyotaki-Moore (1997), ...
- **General Theory of Pecuniary Externalities:** Hart (1975), Stiglitz (1982 etc.), Geanakoplos-Polemarchakis (1986), Greenwald-Stiglitz (1986), ...
- **Distributive Externalities from**
  - **Financial Constraints:** Caballero-Krishnamurthy (2003), Lorenzoni (2008), Korinek (2009), ...
  - **Risk Sharing**: Jacklin (1987), Allen-Gale (2004), Farhi-Golosov-Tsyvinski (2009), ...
- **Collateral Externalities:** Jeanne-Korinek (2010), Benigno et al. (2011 etc.), Bianchi (2011), Stein (2012), ...
- **Both Types of Externalities:** Gromb-Vayanos (2002)

Conclusions

1. General and extensible methodology to characterize pecuniary externalities
2. Categorize two *distinct* types:
   - distributive externalities
   - collateral externalities
3. Describe *sufficient statistics* for optimal taxation
4. Externalities can generally go either way in principle, although typical situations lead to over-borrowing