# Economic Evaluation

## **Lec 10:** The Social Discount Rate (SDR)

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# AM's reminders

- **Lecture slides:** uploaded at Live@Lund
- **Mail policy**
  - **NO content questions by email**
  - Ask during/between classes or just walk over to $\alpha$ 4035B
  - **Office hours on Tuesday, 14:30-16:00**
- **Assignment** is online
  - **Worth 20 points,** but not mandatory
  - **Deadline: March 8$^{th}$ 24:00**
  - Answers by email to alessandro.martinello@nek.lu.se **in pdf format**.
    - Email object as **NEKG51 assignment**
    - Name of the attachment as **surname_name.pdf**
- **Exam:** WiP

# Reading list

- **BGVW ch.10**
- **Recommended readings**
  - Giglio et al. (2014)

# Why discussing SDR (I)

## Project evaluation / CBA

$$NPV = \sum_{t=0}^{N} \frac{1}{(1+i)^t} NB_t$$

- $i$ = SDR = rate of decline of weights / discount factors

# Why discussing SDR (II)

## Choice of SDR crucial

| Year | A | B | C |
|---|---|---|---|
| 0 | -80000 | -80000 | -80000 |
| 1 | 25000 | 80000 | 0 |
| 2 | 25000 | 10000 | 0 |
| 3 | 25000 | 10000 | 0 |
| 4 | 25000 | 10000 | 0 |
| 5 | 25000 | 10000 | 140000 |
| NPV ($i = 2\%$) | 37836 | 35762 | **46802** |
| NPV ($i = 10\%$) | 14770 | **21544** | 6929 |

# Choosing & using a discount rate

**You as analysists:**

- **Choice of SDR**
  - **Pros** & **Cons**
- **Sensitivity analysis**
- If SDR forced onto you (by agency / BGVW), **why it is wrong**

**Today:**

1. Justifying a given SDR **(theory)**
2. Computing (choosing) a SDR **(practice)**
   - 4 different ways (assignment: Sweden)
   - Shadow Price of Capital $\theta$
3. Best practice **(today and tomorrow)**
   - Time-varying Social Discount Rate

# Which SDR makes sense?

# SDR as individual MRTP

**Marginal rate of time preferences (MRTP)**

- How much we prefer a cake now rather than tomorrow
  - **Experimental economics**
- **Consumption**-related measure
- Recall: Intertemporal consumption model **(partial eq.)**
- **General eq. model:**
  - MRTP = market interest rate **under perfect competition**

# Social preferences: adding production

**Investments have returns**

- **Budget constraint concave**
- Social Marginal Rate of Time Preference **(SMRTP)**

**First best economy: X**

$$1 + p_x = 1 + r_x$$

**"Second best" economy: Z**

$$1 + p_z \neq (<) 1 + r_z$$

# Multi-period: Ramsey model

- **Society maximizes welfare over infinite periods**
- **If invest**, consumption increases in future periods

$$p_x = \underbrace{d}_{\substack{\text{pure rate of} \\ \text{time preferences}}} + \underbrace{g}_{\substack{\text{steady-state growth rate} \\ \text{in per-capita consumption}}} \cdot \underbrace{e}_{\substack{\text{elasticity of} \\ \text{consumption prefs}}}$$

- $d$: impatience; $g$: future growth; $e$: consumption smoothing

**At optimum,**

$$\underbrace{r_x}_{\substack{\text{marginal rate of return} \\ \text{on investments}}} = p_x = d + ge$$

Very nice and fine, but...

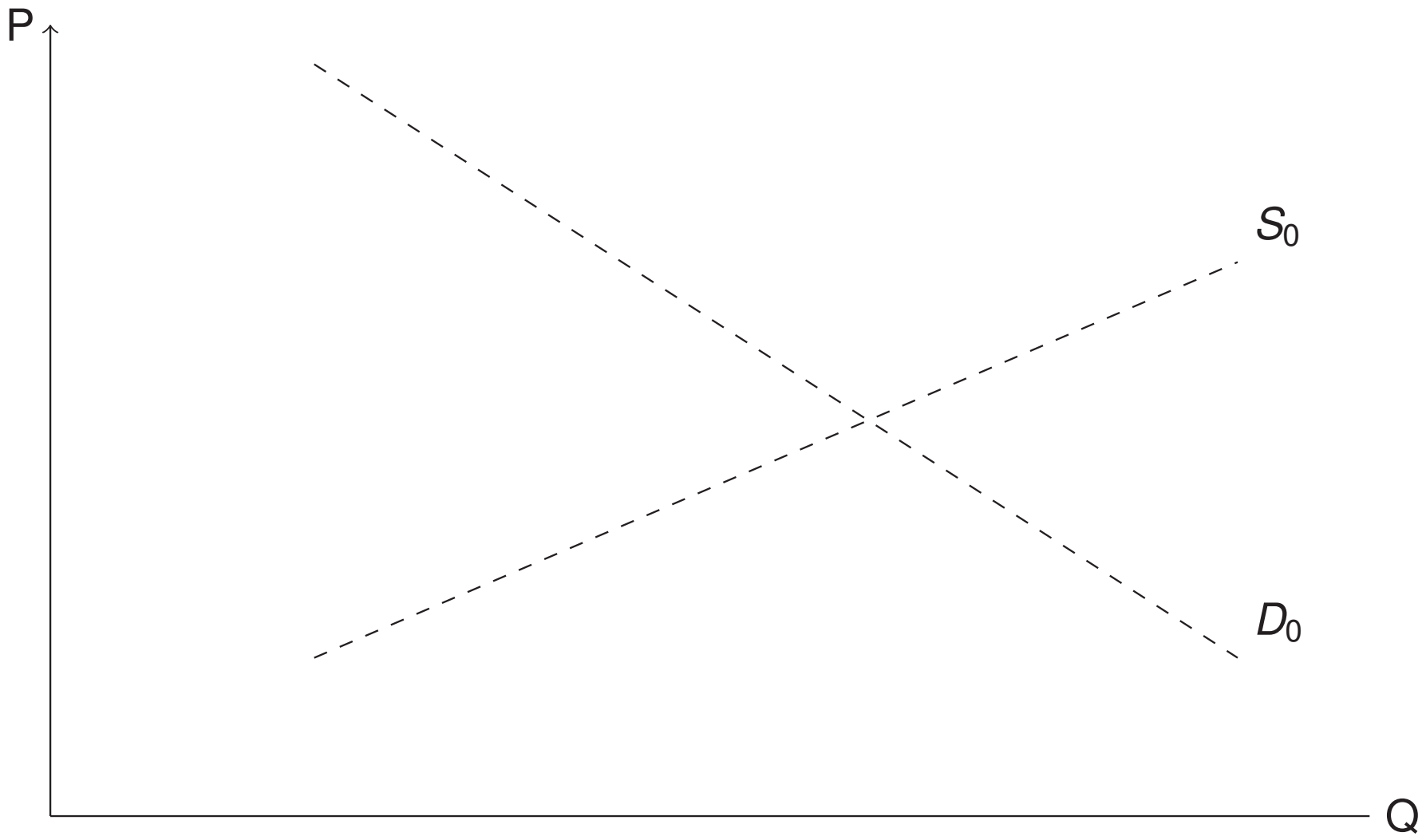
# How to choose a SDR in practice?

# 4 strategies

1. **Marginal rate of return on private investments**
2. **Social marginal rate of time-preferences**
3. **Government's real borrowing rate**
4. **A mix of the three**
   - **Simple weighted average**
   - **Shadow price of capital $\theta$**
   - **Optimal growth rate**

**! We operate in a "second-best" scenario**

# Harberger's model (I)



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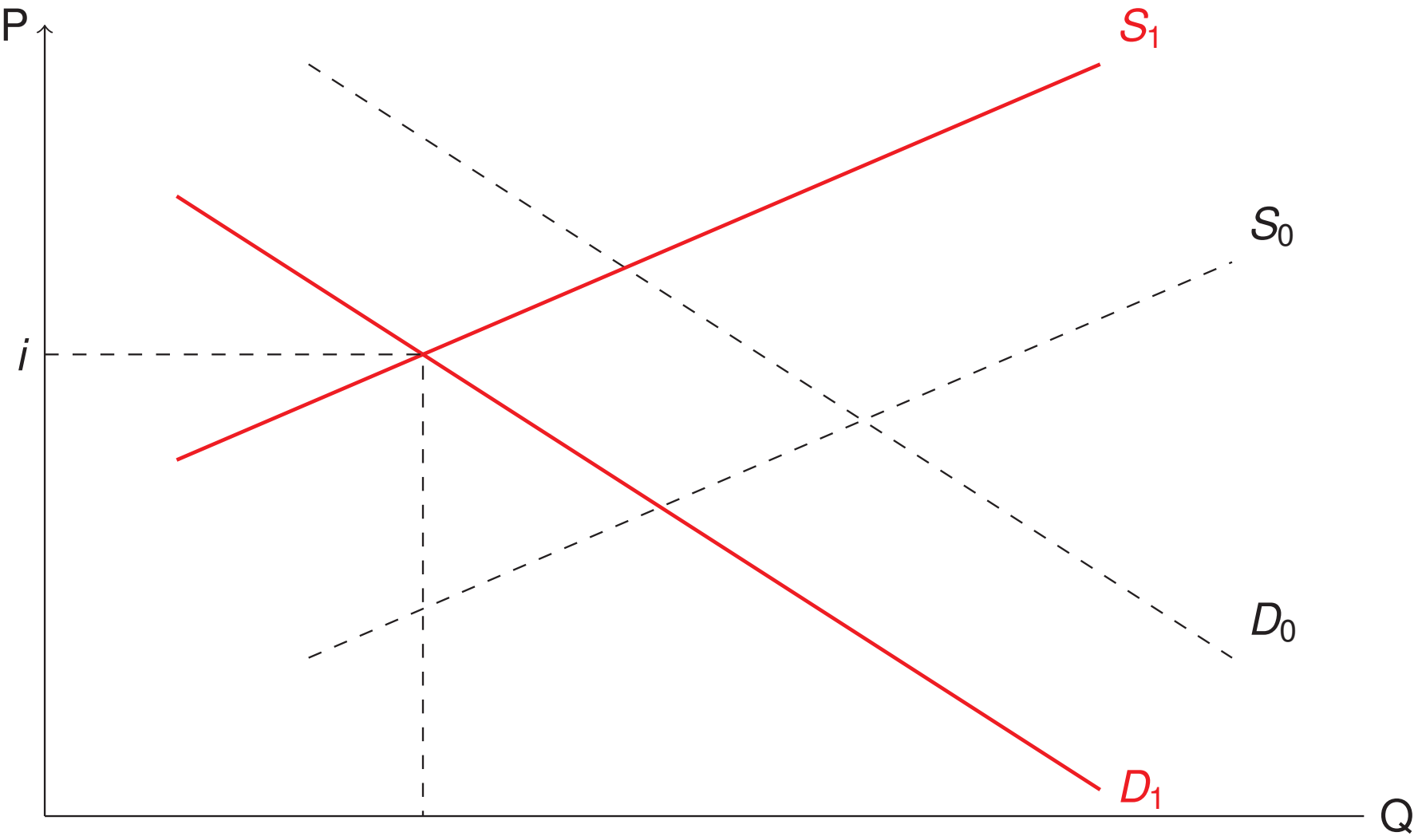

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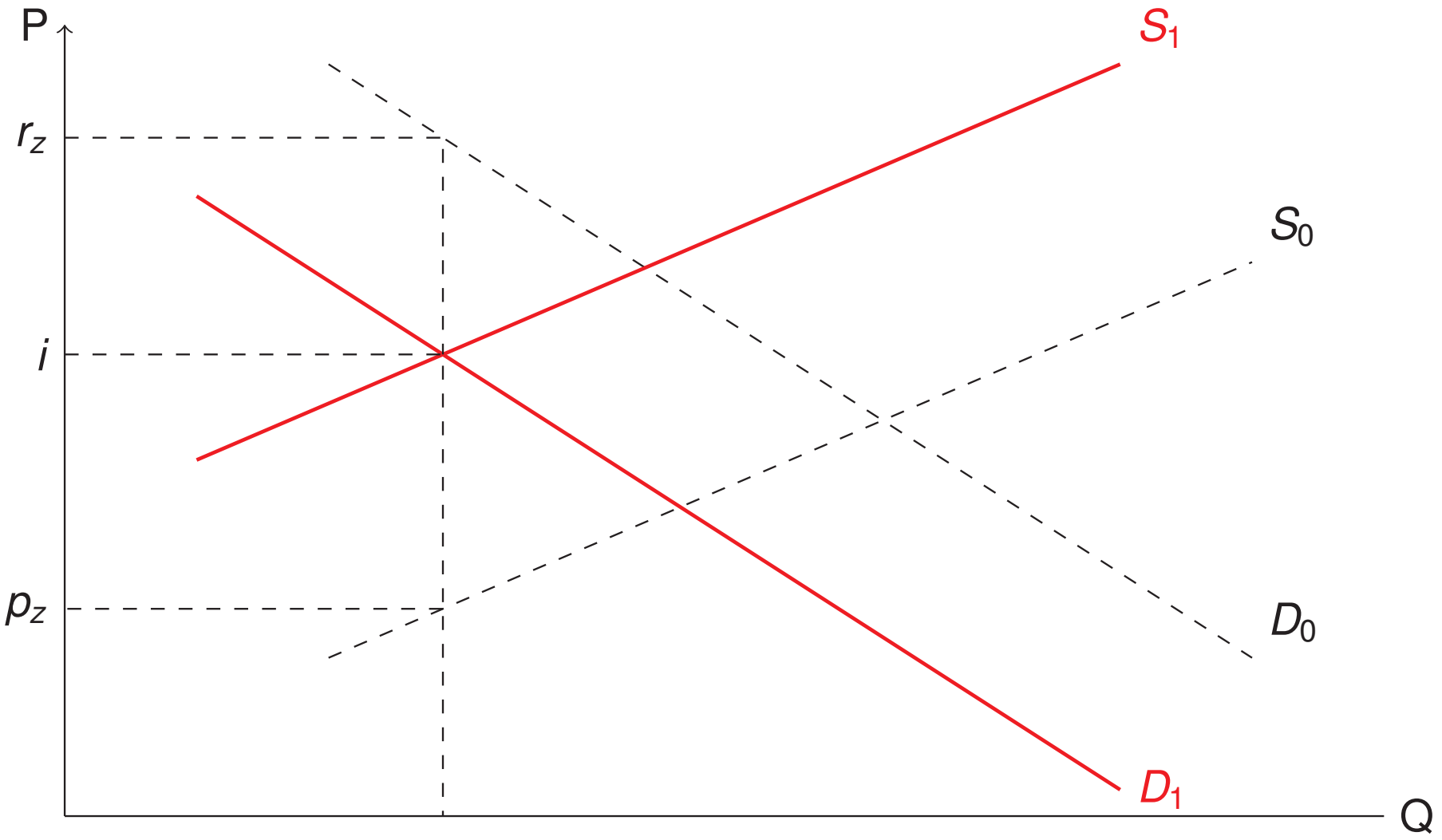

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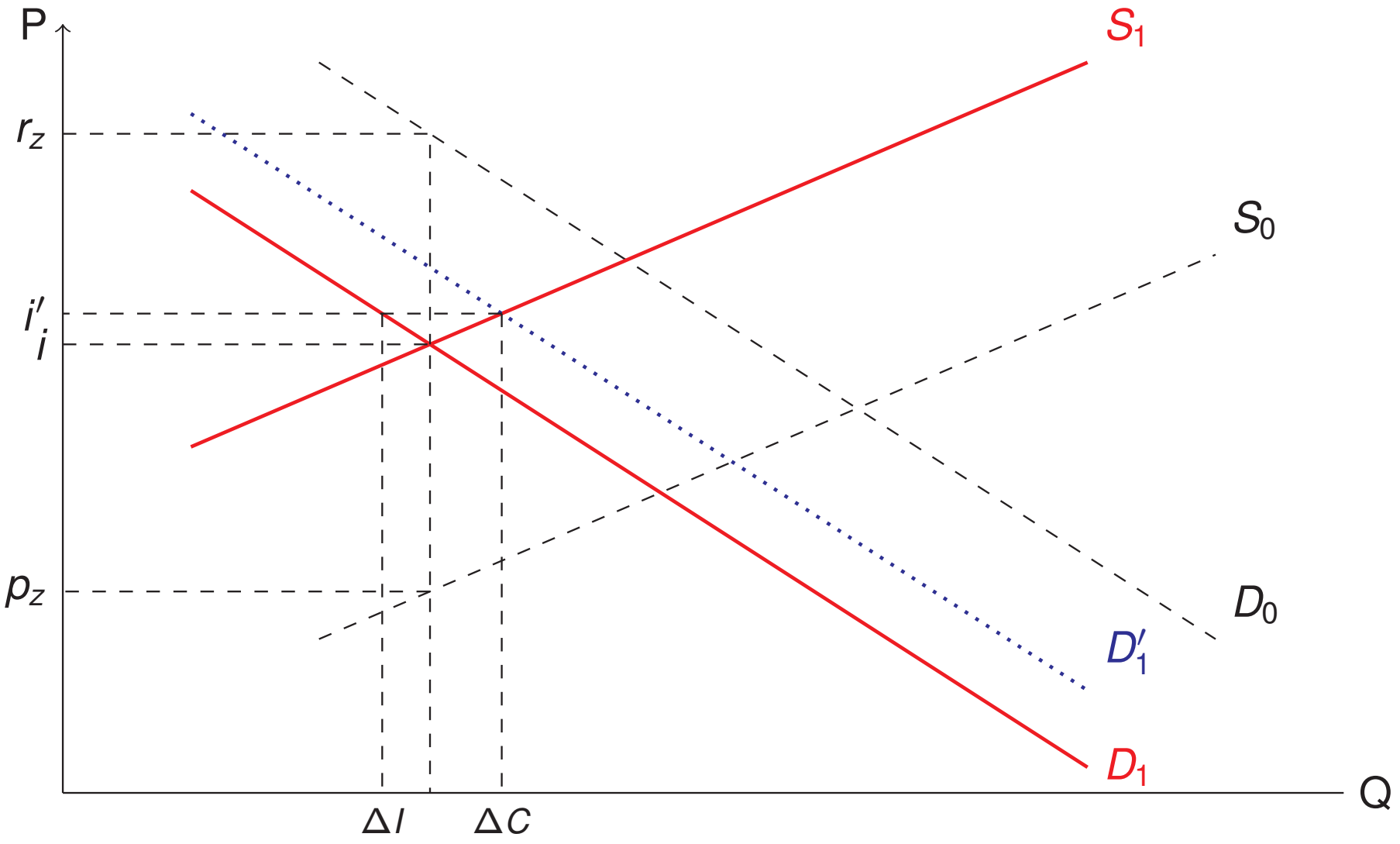


# Harberger's model (II)

- **Borrowing in a close market**
  - **Social point of view:** pay interest to own citizens, not a cost
- **SDR obtained by weighting rates** according to how much is financed by **consumption** and **investment**
- **Weighted Average Cost of Capital (WSOC)**

$$WSOC = \underbrace{\frac{\Delta I}{\Delta I + \Delta C}}_{a} \cdot r_z + \underbrace{\frac{\Delta C}{\Delta I + \Delta C}}_{b=1-a} \cdot p_z$$

# Marginal rate of return on private investments

**Savings respond little to $\Delta$s in interest rates**

- Supply inelastic, $b \approx 0$
- Public drains resources **from private investments**
- **Marginal return $<$ average returns**
  - Use corporate **bonds**, not equities (also no risk premiums)

## BGVW

- Moody's AAA-corporate bonds adjusted for inflation
- Before-tax return $\approx$ 4.5%

# Marginal rate of return on private investments

## Criticisms

1. Private-sector rate of returns too high wrt society benefits
   - Externalities
2. Even bonds have risk premium that GVMT has not
3. If project financed by taxes, crowd-out of consumption
4. Borrowing from other countries?
5. Pool of investment not fixed
   - Public intervention can increase pie size

$\Longrightarrow$ **$r_z$ as an upper limit**

# Social marginal rate of time-preferences

**Public sector expenditure crows out consumption** (taxes)

- Reward for postponing cons.: return on **risk-free asset**
- After-tax, real medium-term GVMT bonds (10-years)
  - **US:** marginal tax rate. . .
  - **SE:** Capital income tax fixed

## BGVW

- Using US 10-years treasury bond yelds, $p_z \approx 1.5\%$
- Sensitivity analysis at 1% and 2%

# Social marginal rate of time-preferences

## Criticisms

1. As $p_z < r_z$, resources could be **better used in private sector**
2. Huge **heterogeneity** in individual preferences
   - Savers VS borrowers
   - Borrowers have higher returns on savings
3. **Individuals behave inconsistently**

   $\Longrightarrow$ no single marginal rate of time-preferences
   - **Credit card puzzle**
   - Hyperbolic discounting

# Government's borrowing rate

**Private sector expenditure financed by borrowing abroad**

- Interest paid by government for borrowing
- Average real monthly yeld on 10-years GVMT bonds

## BGVW

- US: $i \approx 2.7\%$
- Sensitivity analysis at 1.7% and 3.7%

# Weighted average approach

## Weighted Social Cost of Capital

$$WSOC = ar_z + bp_z + (1 - a - b)i$$

- Values of $a$ & $b$ depends on how a project is financed

## Criticisms

- **Many same as before**
- **Introduces additional assumptions** that tipically government officials do not like
- **Apparent issue:** returns on private market are higher
  - Public could undertake projects that the private would not

# Shadow price of capital

**Intuition: crowding-out private investment is very costly**

- Decreasing investment $\implies$ decreasing consumption growth
- $\Delta$s in private sector investment flows weighted by $\theta > 1$

**Proceed in steps**

1. Divide costs/benefits between **consumption** and **investment**
2. Convert investment flows in **consumption equivalents** via $\theta$

$$\theta = \frac{(r_z + \delta)(1 - f)}{p_z - r_z f + \delta(1 - f)}$$

   - $\delta$: **depreciation rate;** $f$: **proportion reivested**

3. Consumption equivalents are then all discounted by $p_z$

# Example

$\theta = 1$

| Year | Investment flows | | Consumption flows | | | NB |
|---|---|---|---|---|---|---|
| | Borrow | Repay | Int. | Tax | Pr. ben. | |
| 0 | -3000 | 0 | 0 | 0 | 0 | -3000 |
| 1 | 0 | 553.854 | 120 | -673.854 | 700 | 700 |
| 2 | 0 | 576.008 | 97.846 | -673.854 | 700 | 700 |
| 3 | 0 | 599.048 | 74.806 | -673.854 | 700 | 700 |
| 4 | 0 | 623.010 | 50.844 | -673.854 | 700 | 700 |
| 5 | 0 | 648.080 | 25.774 | -673.854 | 700 | 700 |

**Discounting at** $p_z = 1.5\% \implies NPV = 347.852$

# Example

$\theta = 1.33$

| | Investment flows | | Consumption flows | | | |
|---|---|---|---|---|---|---|
| Year | Borrow | Repay | Int. | Tax | Pr. ben. | NB |
| 0 | -3990 | 0 | 0 | 0 | 0 | -3990 |
| 1 | 0 | 736.626 | 120 | -673.854 | 700 | 882.772 |
| 2 | 0 | 766.091 | 97.846 | -673.854 | 700 | 890.083 |
| 3 | 0 | 796.734 | 74.806 | -673.854 | 700 | 897.686 |
| 4 | 0 | 828.603 | 50.844 | -673.854 | 700 | 905.593 |
| 5 | 0 | 861.946 | 25.774 | -673.854 | 700 | 913.866 |

**Discounting at** $p_z = 1.5\% \implies NPV = 303.709$

# Recommendations and criticisms of $\theta$

## BGVW

- $\theta \approx 1.33\%$ & $p_z \approx 1.5\%$
- Sensitivity at $\theta = 1.47, p_z = 1\%$ and $\theta = 1.21, p_z = 2\%$

**Criticisms**

1. **Hard** to explain $\Longrightarrow$ skeptical policy-makers
2. **Higher information requirements**
3. Allows for more **manipulation**
4. As formula for $\theta$ uses $p_z$ and $r_z$, **subject to same criticisms**

$\Longrightarrow$ **almost never used in practice**

# Optimal growth rate method

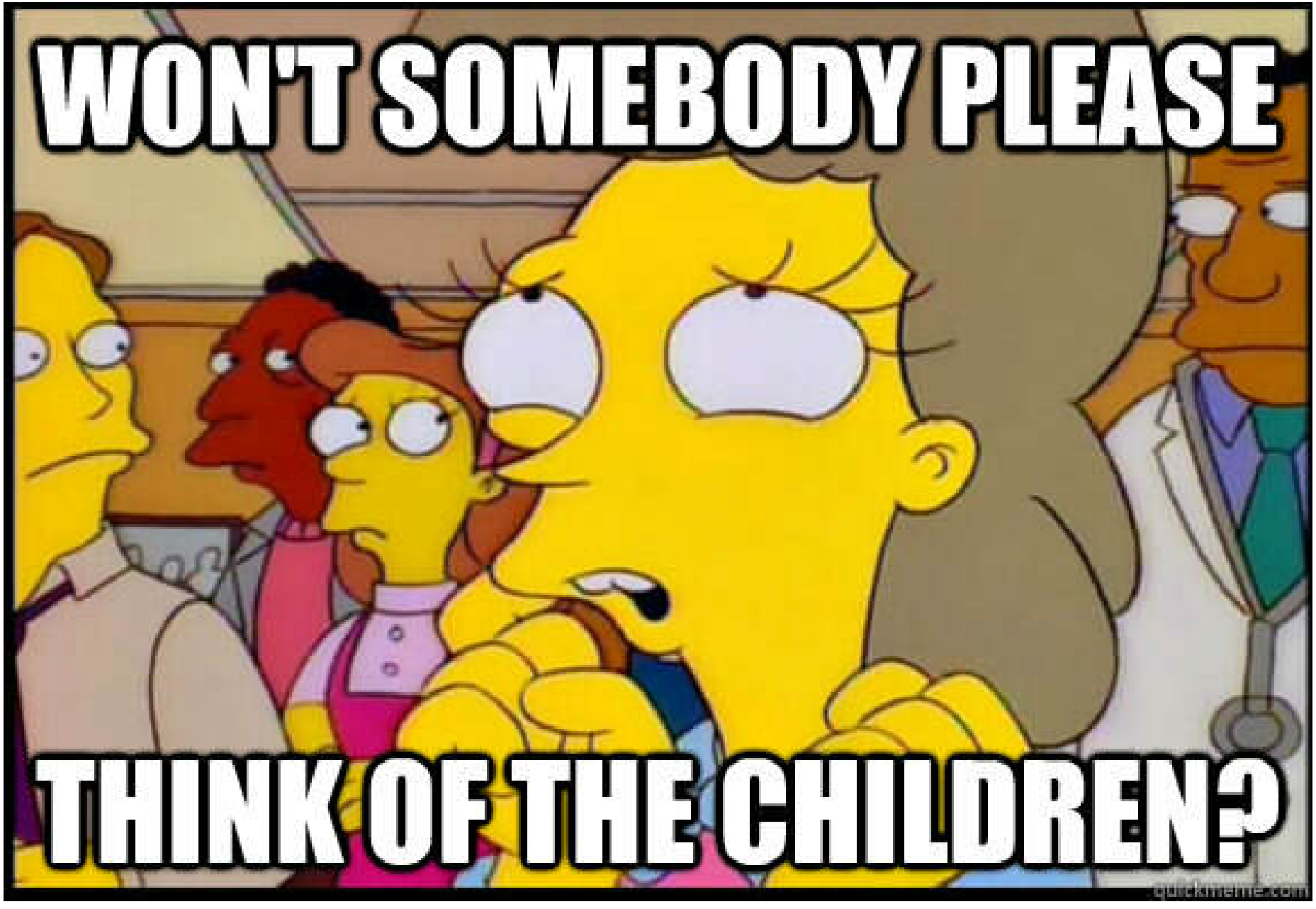
- **Back to theory - Ramsey's model**

$$r_x = p_x = d + ge$$

- Plug in values from literature
- **SPC appicable**: substitute $p_x$ for $p_z$

## BGVW

- $d = 1\%$; $g = 2\%$; $e = 1.3$
- $\implies$ $p_x = 3.5\%$ ($\theta = 1.1$)
- Sensitivity at $p_x = 2\%$ ($\theta = 1.32$) and $p_x = 6\%$ ($\theta = 1$)


WON'T SOMEBODY PLEASE
THINK OF THE CHILDREN?
quickmeme.com

# Would this pass a CBA?

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# Would this pass a CBA?

- **Malaga Cathedral:** started in 1528, completed in 1782
- Present value of 1B$ in 254 years?
  - 4.5% SDR $\Longrightarrow \approx$ 14K$
  - 487yrs $\Longrightarrow \approx$ 0.5$

# Intergenerational discounting

1. Is any of the theories we discussed appropriate for e.g. **climate policies**?
   - Less resources $\Longrightarrow$ foregone income
   - Can I turn income into foregone benefits?
2. **Standing of future generations greatly discounted**
   - **Intergenerational transfers (via debt)**
   - **Giglio et al. (2014):** Individuals do not discount far future
   - **Laibson. (1997):** Hyperbolic discounting

# Time-declining discount rates

## Also to incorporate uncertainty

- The $\nearrow$ uncertainty, the $\searrow$ should the SDR be in the future

$$\text{Tipically} \quad E_x\left[\frac{1}{(1+x)^t}\right] \neq (<) \frac{1}{(1+E_x[x])^t}$$

## BGVW

- **Optimal growth model**
  - 3.5% from 0-50 years
  - 2.5% from 51-100 years
  - 1.5% from 101-200 years
  - 0.5% from 201-300 years
  - 0% afterwards