

# Social and individual well-being: metrics and criteria for infrastructure decision-making

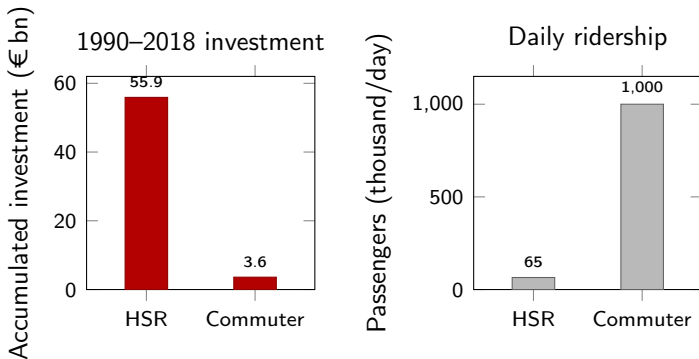
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# Infrastructure decision problems: the example of railways in Spain, 1990–2018

- **Initial motivation:** there has been a serious **lack of criteria** for decision-making in public infrastructures in Spain.
  - **Example:** Investment in railways, 1990–2018 (AIReF 2020):
    - €55,888 million in **High-Speed Rail**; 65,000 passengers/day (medium- and high-income).
    - €3,600 million in **Commuter Rail** (*Cercanías*); over 1 million passengers/day (low- and medium-income).
- \* Problem now: maintaining HSR at 1–2%  $\implies$  more than 1 billion yearly

# High-Speed vs Commuter Rail: Does it make sense?



(even if we account for the different average length of rides)

# This talk

- **Question:** Which **criteria** should guide **decisions on infrastructure**?
  - Efficiency
  - Equity, including a gender perspective
- **Goal:**
  - To outline a possible **framework** for **integrating equity** —including the gender dimension— into **RIGOROUS and OPERATIONAL criteria** for infrastructure decisions.
    - \* (responding to *ad hoc* critiques)
- **Plan of the talk:**
  - ① Cost–benefit analysis and the distributional impact of policies.
  - ② A tool to combine the two: Social welfare functions.
  - ③ Some practical implications on infrastructure decision-making.

# The conventional criterion in infrastructure decisions

- What is the generally accepted criterion for rigorous decision-making on public investment and policy?

## Social Cost–Benefit Analysis (CBA)

- **Central concept:** quantification of all
  - **social benefits** of the action (reduced travel time, noise, emissions, accidents, etc.).
  - **social costs** of the action (environmental, financial, etc.)
- **Criterion:** *Social Benefits* — *Social Costs*  $> 0$ 
  - Prioritization by Net Present Value/Social Rate of Return.
  - Some analytical and practical **complexity**:
    - \* Demand forecasts, willingness-to-pay surveys, time saved and its value...

# Spain: new Sustainable Mobility Law (BOE, 4 Dec 2025)

- Little tradition of applying CBA in Spain (and in economics faculties!).
  - **European Union**: pressure for Spain to apply this criterion.
- **Spain**: Ley de Movilidad Sostenible (BOE 4-12-2025):
  - ① **Mandatory** ex-ante Social CBA for every new transport infrastructure project above a given budget.
  - ② **Ex-post analysis**: mandatory evaluation five years after the infrastructure enters service.
    - \* Checking whether reality (number of users, time savings, final cost) matches what was planned in the ex-ante CBA.
- New rules of the game! **How it is applied** will be key.
  - Attempts to influence decisions on major infrastructure in Spain (e.g. a **gender** perspective) will have to be **channelled** through this law.

# The distributional effects of policies

- Is CBA enough?
  - ① The **objective of public policy** is not output maximization but the maximization of **Social Welfare**.
  - ② **Inequality** reduces social welfare.
  - ③ **All** public investment and policies have **distributional effects** (road tolls, trade liberalization, HSR/commuter rail...).
  - => Social CBA **should also account** for distributional consequences
- **Usual approach**: separating efficiency and equity.
  - First, maximize output (following standard CBA).
  - Second, apply redistributive policies if inequality is excessive.
- It is very **useful to separate** efficiency from equity **conceptually**.
  - **In practice, it cannot be done** completely.

# Can efficiency and equity be fully separated?

## ① Policies are typically **distortionary**:

- There are no investment policies without distributional effects, nor redistributive policies without effects on efficiency.
  - \* A policy may raise net output yet reduce welfare if raising inequality.
  - \* An investment might fail CBA initially but pass it if it reduces inequality (and helps avoid distortionary policies).
  - \* Redistributive policies have a limit: targets are hard to reach.  
“Equalizing” investments are a good additional instrument.

## ② The **CBA computation depends on the distribution**.

- E.g. the value of time saved with new infrastructure depends on the user's income: higher income  $\implies$  higher value.
  - \* Relative value of time, **BUS / Car-Train user = 0.72**;
  - \* Relative value of time, **BUS / Air user = 0.48**.
- $\implies$  CBA **favours** investments that benefit high-income individuals.
- The **distributional impact must be incorporated into the CBA!**



# How to measure social welfare?

## Social Welfare Functions (SWF)

- An *SWF* assigns a level of social welfare to each vector of individual welfare levels (Bergson 1938; Samuelson 1947).
  - In a society with  $n$  individuals,  $W(u) : \mathbb{R}^n \rightarrow \mathbb{R}$  gives social welfare for each vector  $u = (u_1, u_2, \dots, u_n)$  of utilities.

**It aggregates individuals' welfare into a measure of social welfare.**

# The philosophical foundations of SWFs (I)

- What functional form and what foundation does a SWF have?
  - Ethics, Moral Philosophy and Political Philosophy: the study of equity and justice  $\implies$  they should provide the foundations.
- Most famous case: **Utilitarianism**:

$$W(u) = \sum_{i=1}^n u_i.$$

- **J. Bentham** (1748–1832): “*the greatest happiness of the greatest number*”.
- Modern version: J. Harsanyi (1953, 1955, 1977):
  - \* Rule utilitarianism, not act utilitarianism.
  - \* **Veil of ignorance**: which rules would you set in society before being born rich or poor?
  - \* (Beware of some caricatures)

## The philosophical foundations of SWFs (II)

- **Other philosophical approaches  $\implies$  other SWFs:**
  - Maximin/Leximin (John Rawls):  $W(u) = \min(u_1, u_2, \dots, u_n)$ .
  - Prioritarianism:  $W = \sum_{i=1}^n g(u_i)$ , where  $g'(u) > 0$  and  $g''(u) < 0$ .
  - Capabilities and basic consumption:  $W(u) = \sum_{i=1}^n \ln(x_i - \underline{z})$ .
- (It would be desirable a closer dialogue between **philosophers and economists**)

## Implication for CBA: weighting of effects

- **Implication** of welfare analysis for CBA?
  - Costs and benefits must be **weighted** according to who receives them.
- **Example.** Typical **isoelastic (CRRA)** utility function in income  $y_i$ :

$$W(u) = \sum_{i=1}^n u(y_i) = \sum_{i=1}^n \frac{y_i^{1-\gamma}}{1-\gamma}, \quad \gamma > 1.$$

- If a policy changes  $y_i$ , differentiating  $W(u)$  with respect to  $y_i$ :

$$dW(u) = \sum_{i=1}^n \left( \frac{1}{y_i} \right)^{\gamma} dy_i.$$

- **Implication:** individual  $i$ 's benefits must be **weighted by the inverse of income** raised to the parameter  $\gamma$ :  $1/y_i^{\gamma}$ .

## Which value of $\gamma$ ? Empirical evidence

- Many empirical studies estimate  $\gamma$  (observation, dilemma surveys, experiments). Two prominent ones:
  - Layard, Mayraz, and Nickell (2008). “The marginal utility of income,” *Journal of Public Economics*, 92(8–9), 1846–1857.
    - \* Suggested value:  $\gamma = 1.3$ .
  - Acland and Greenberg (2023). “The Elasticity of Marginal Utility of Income for Distributional Weighting and Social Discounting: A Meta-Analysis,” *Journal of Benefit-Cost Analysis*, 14(2), 386–405.
    - \*  $\gamma$  **between 1.2 and 2; suggested value: 1.6.**
    - \* Example: two individuals with  $y_j/y_i = 2$   
 $\implies$  weight on  $i$  relative to  $j = (y_j/y_i)^{1.6} = 2^{1.6} = \mathbf{3.03!}$

## Again: the value of time savings in CBA

- **Recall** the different **values of transport time savings in Spain** given by wage level (= income):
  - Relative value of time:  $\text{BUS/Car-Train} = 0.72$ ;  $\text{BUS/Air} = 0.48$
- **Now weighting** the benefits of time savings:
  - $\text{BUS/Car-Train} = 0.72 \left( \frac{1}{0.72} \right)^{1.6} = 1.22$ ;
  - $\text{BUS/Air} = 0.48 \left( \frac{1}{0.48} \right)^{1.6} = 1.55$ .
- **SWF: the direction** of the CBA's initial treatment **is reversed!**
  - The value of time is higher for richer individuals, but we must give more weight to welfare improvements for individuals with lower welfare.

# CBA in the World: is the distributional effect taken into account?

- Several countries provide suggestions and some guidance but it is not compulsory (examples):
  - **UK:** HM Treasury (2022), *The Green Book* — account for it only if the impact is potentially significant.
  - **Netherlands:** CPB, *Distributionally Weighted CBA* (Discussion Paper 364).
  - **New Zealand:** Waka Kotahi NZ Transport Agency (2022), report 700.
  - **European Union:** EC (2021), *Study on Distributional Impact Assessment*; EC (2022) Communication on the distributional impact of Member States' policies — mainly tax and transfers.
  - **Spain:** discussed in the Advisory Council of the Ministry of Transport and Sustainable Mobility.

# Implications for gender inequality?

- Gender inequality: **one of the dimensions of inequality!**  
⇒ This approach can **justify** incorporating criteria for decision-making on infrastructures that favors women.
  - If women have lower income or welfare (e.g. less free leisure time), **benefits accruing to women** should be weighted by a higher factor.
- The **CBA of infrastructure** should:
  - ① Collect **information** on potential users by income and gender.
  - ② **Weight** benefits according to beneficiaries' income and gender.
- The **Ley de Movilidad Sostenible (2025)** requires CBA for transport infrastructure above a certain investment threshold:
  - ⇒ The society could push for the CBA to **account for equity** and gender perspective.



## Connection of this approach to the IHDI (UNDP) and to some gender inequality indices

- The **foundations of the framework** developed here are the same as the ones of the **Inequality-adjusted HDI** (and GDI):
  - the use of **SWF**.
- **Inequality-adjusted HDI** (UNDP, 2010):
  - Data of each dimension of HDI (life expectancy, education, income) are averaged using geometric mean instead of arithmetic mean.
  - What is the **foundation for this?**:
    - \* Utilitarian **SWF** with logarithmic utility functions.
    - \*  $W(y) = \frac{1}{n} \sum_i^n \ln(y_i) = \ln(\prod_i^n y_i)^{1/n}$   
(ut. of geometric mean of  $(y_i)$   $\Rightarrow$  more inequality implies lower index.)

## Concluding...

- **Decisions** on public policies and infrastructure should be subject to **transparent criteria** of:
  - ① Efficiency (CBA)
  - ② Equity (including the **gender** dimension)
- We can **make progress** in this direction on the basis of
  - ① Rigorous Principles,
  - ② Operational Tools.
- **Implications** of the approach presented here:
  - ① Collect **information** on beneficiaries by income and gender (and, possibly, other relevant elements such as time poverty).
  - ② **Apply weights to benefits in CBA**, accordingly (i.e., higher weights to lower income and welfare subjects like women).