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FINDING A BETTER WAY

A Comparison of Unit Price and Fixed Price Contracts for Infrastructure Construction Projects

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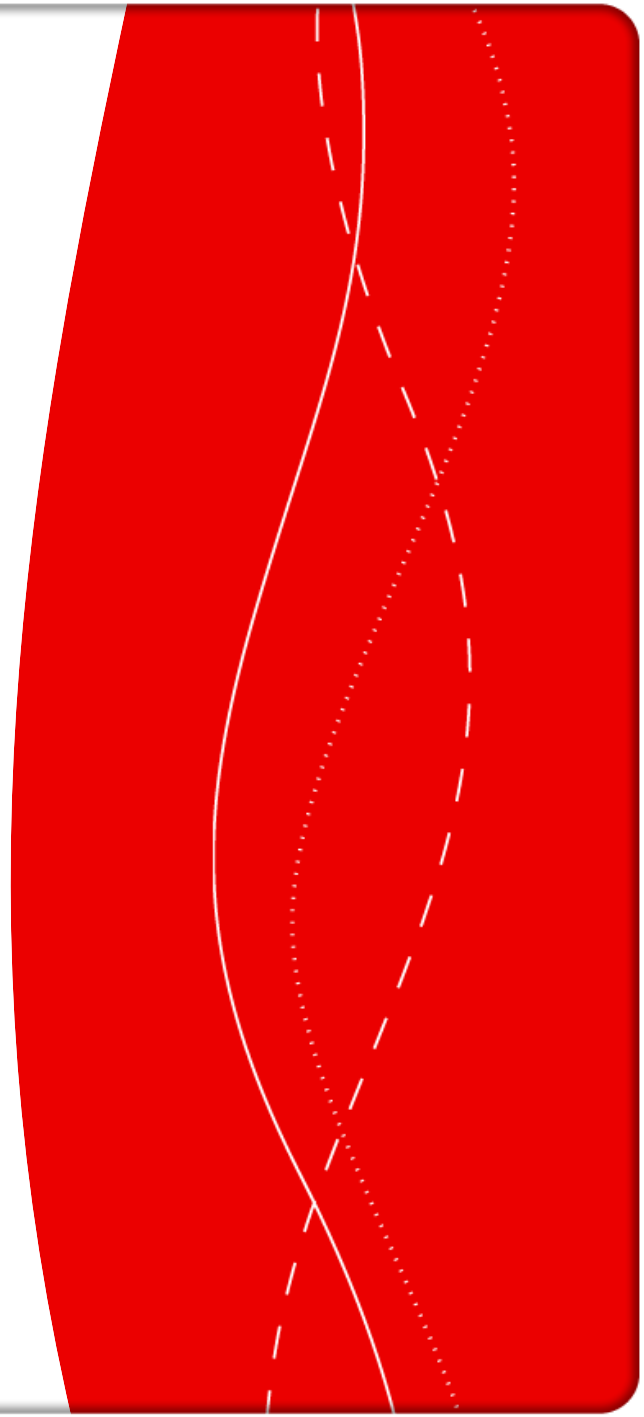


Aim and approach

Purpose: To compare types of construction contracts; Unit Price Contracts (UPC) and Design Build (DB)

UPC – fixed unit prices, e.g., SEK per ton gravel moved

DB – fixed price for a given outcome

Given that UPC is far more frequent than DB. From our data 2000-2009

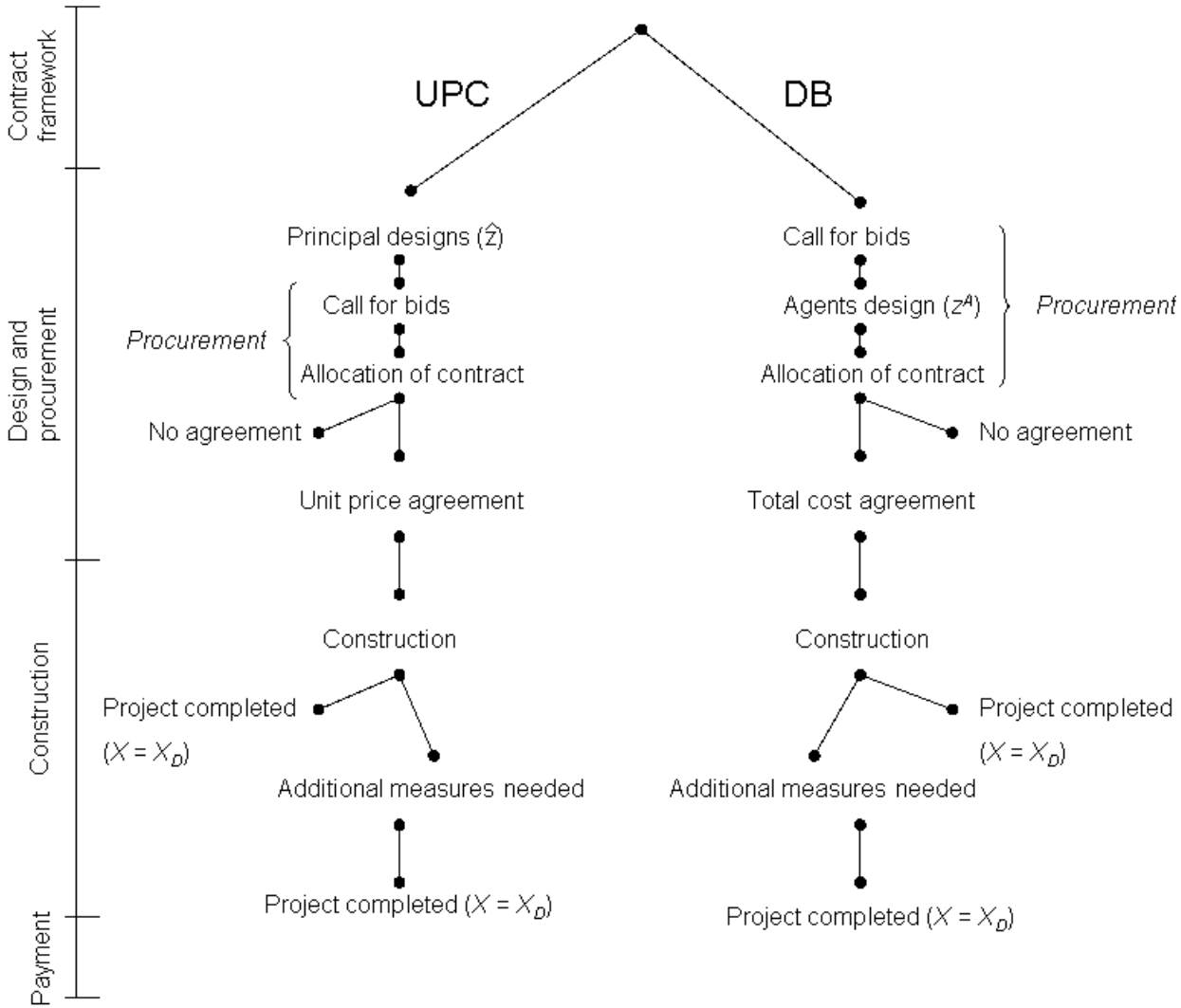
- Number of projects; 1323 vs 86
- 25 723'' vs 8 934'' SEK

Why is UPC so common?

Three stages:

1) Derive a naïve model – supporting DB
2) Relaxing assumptions – showing UPC's merits
3) Comparison with some empirical observations

UPC vs DB – a framework



The model

- X_D – a road with certain desing features between Here and There
- Z = $\{z_1, z_2, \ldots, z_n\}$ – inputs required to build the road.
- To simplfy $X_D = X_D(z_1, z_2)$
- z_1 – m^3 gravel, z_2 – hours of compacting to build the road

- With UPC
- Princpal defines Z, say $\{\hat{z}_1, \hat{z}_2\}$
- Bidders submit a bid vector P, say $\{p_1 p_2\}$
- Lowest vector product PZ wins,
- Winner get payment up to PZ

- With DB
- The bidder with the lowest bid B wins the contract and is paid

The naïve result

- Several possible ways of reaching a desired outcome
- Which costs less depends on relative input prices and available technology
- The agent is likely better informed about both.

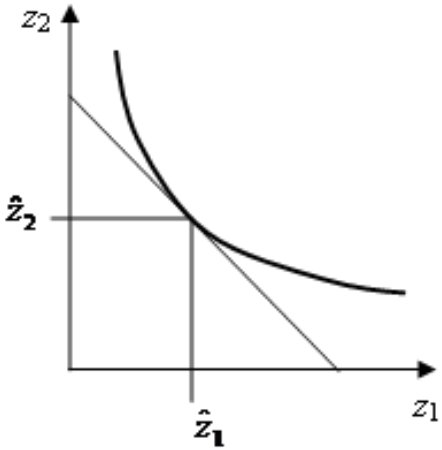


Figure 2a

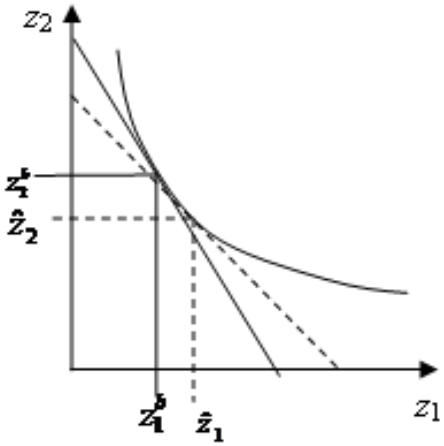


Figure 2b

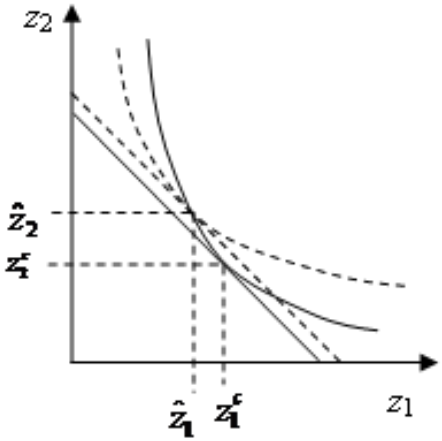


Figure 2c

Agent's superior information → DB is cost effective

The naïve model (cont.)

- The problem to identify the cost minimising solution to have it built increases with project ”complexity”.
- A project is more complex the more curved are the isoquants
  - No complexity at all with Leontief technology
- A project is more complex the larger the input vector
  - Makes it more difficult to identify the cost minimising solution.

Extensions

The naïve model: DB always (weakly) outperforms UPC

This does not fit with the empirical situation.

We focus on three underlying assumptions in the naïve setting

1) Designing the project is costless
2) Both input and output is perfectly observable
3) There is a certain mapping from input to output

Conjectures from allowing costly design phase

DB yields (partly) sunk design costs for bidders that don't win:

1 – DB more costly when (expected) number of bidders is large

2 – Harder to outweigh design costs if no or few alternative designs

Possible impact on agent behavior of costly design:

On the one hand, with many competing bidders; less incentives to innovate due to small chance of winning,

On the other, more innovation needed in order to place winning bid

Moreover, DB may result in few bidders if sunk costs are believed to be high

Conjectures from limited observability of input and output

Some output observable, some unobservable (”quality” of a road). From the ”equal compensation principle”; little effort will be spent on unobservables.

Under UPC output quality can be controlled by way of detailed specification of the input vector.

Under DB costly monitoring of output

1 – UPC relatively better if unobservables are ”large”

2 – UPC relatively better if monitoring input costs less than monitoring output

Conjectures from relaxing the certain mapping from input to output

Under UPC:

The principal carries the risk of inputs not leading to desired output

The agent carries the risk that the bid will not cover actual costs

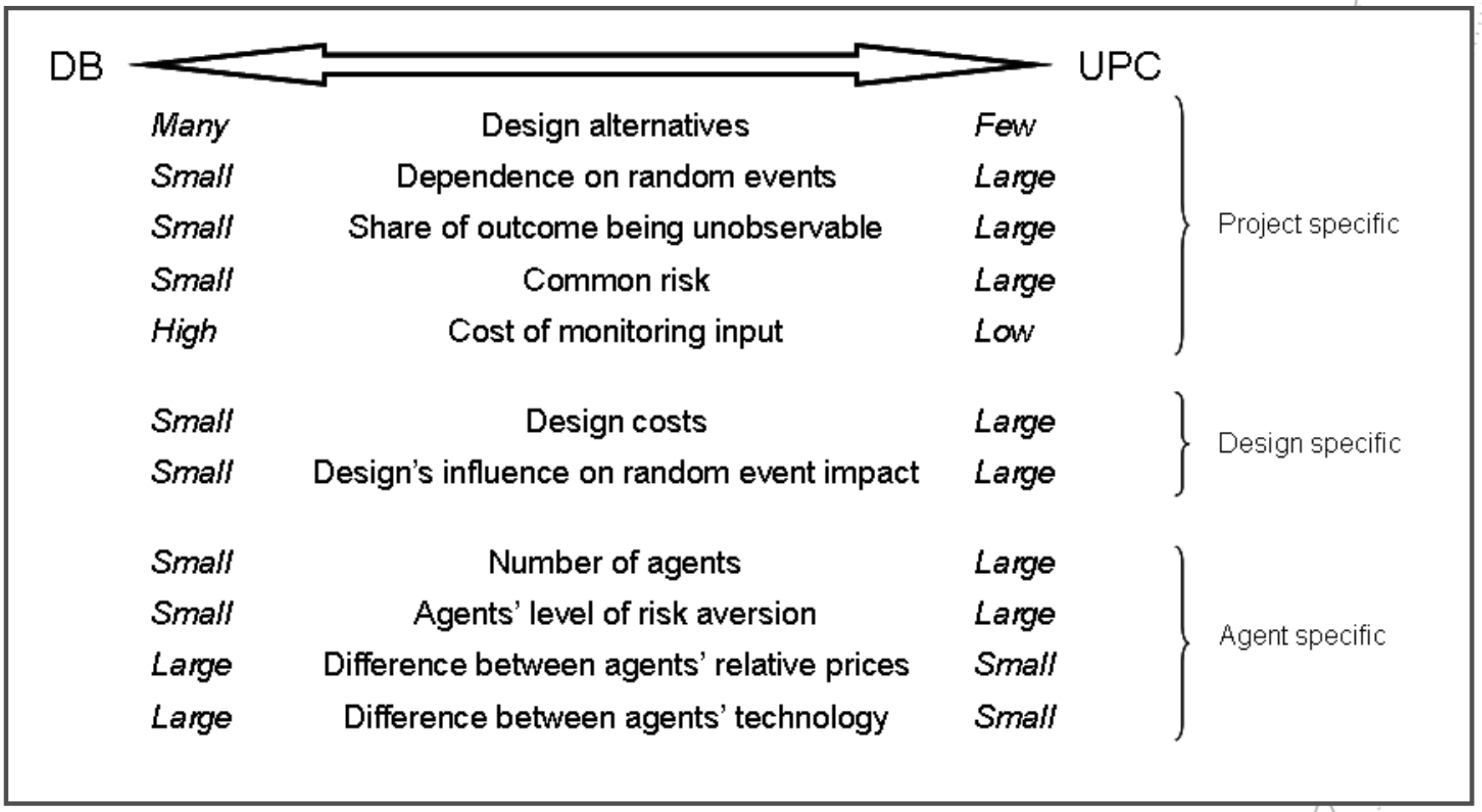
Under DB:

The agent carries both risks – and requires compensation (i.e., higher expected surplus)

1 – UPC is relatively better when agents are more risk averse

2 – UPC is relatively better when (common) risks are higher

Summing up the conjectures



Empirical observations

Data on ~1400 contracts tendered by the Sweden's National Road Administration between 2000 and 2009

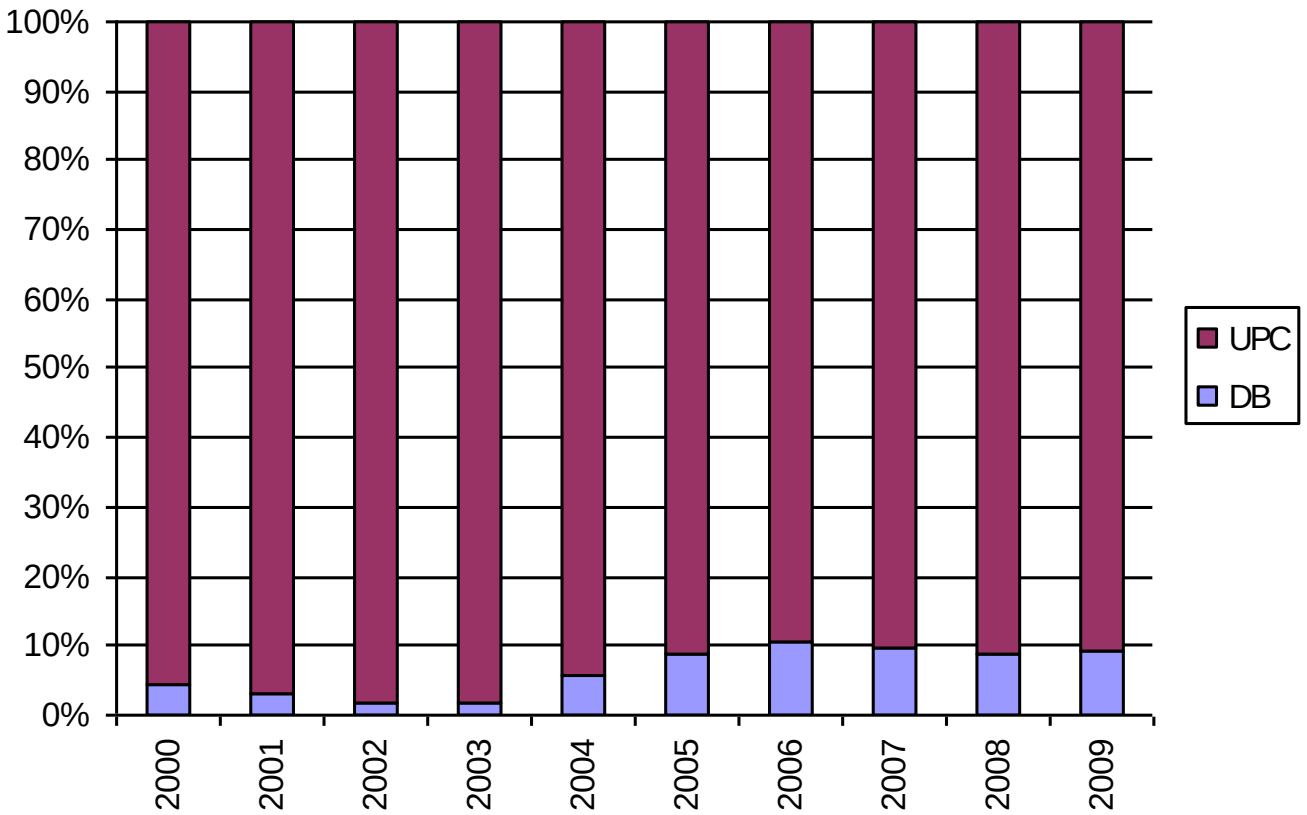
Data includes:

- Year, district, etc.
- Expected construction duration
- Type of project (road, bridge, bus stop etc.)
- All bids submitted and identity of bidders
- Contract sum
- Type of contract (UPC, DB)

A major problem is to compare likes with likes; we now have registered information about vital inputs (m2 asphalt, m3 earth or rock excavation etc.) to provide a proxy for what has been built.

UPC far more common than DB

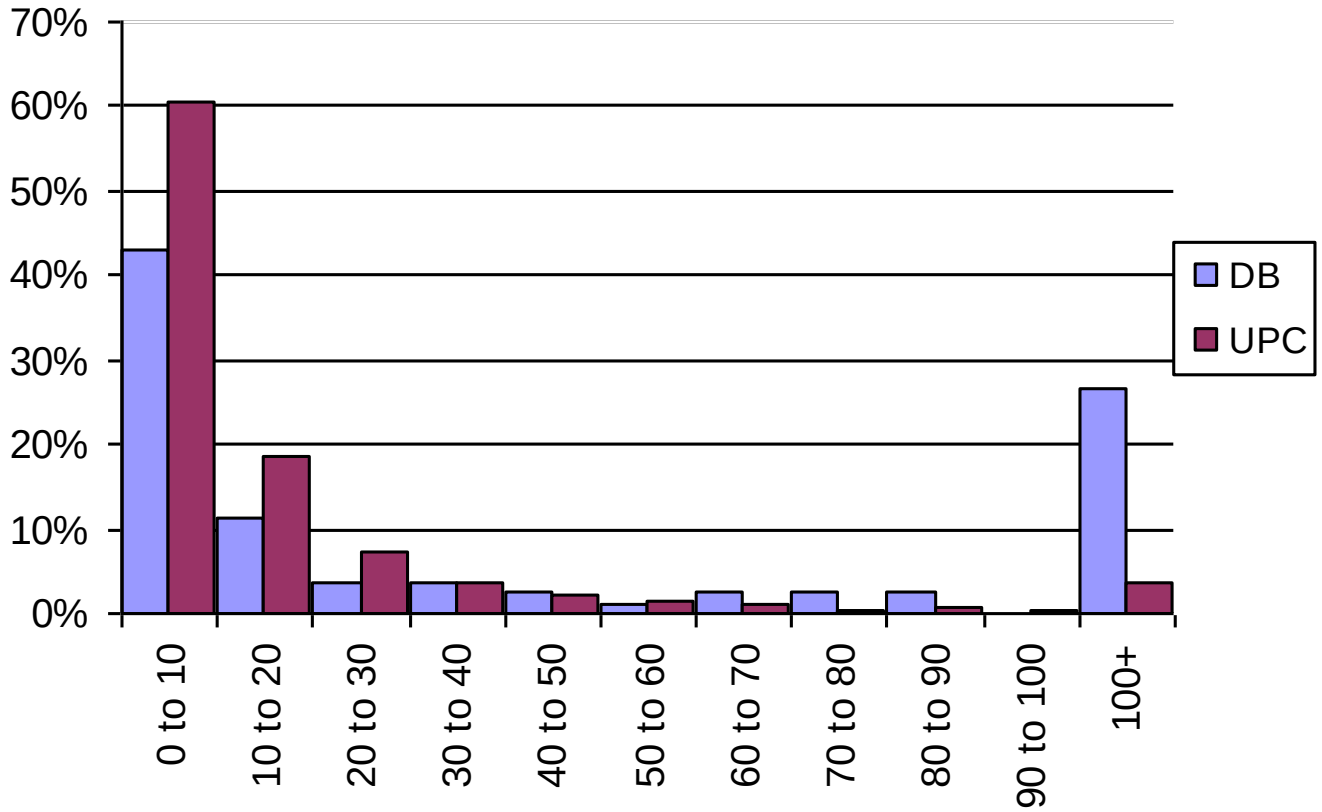
Share of number of projects each year:



DB and UPC used for different projects (1)

Difference in contract sum

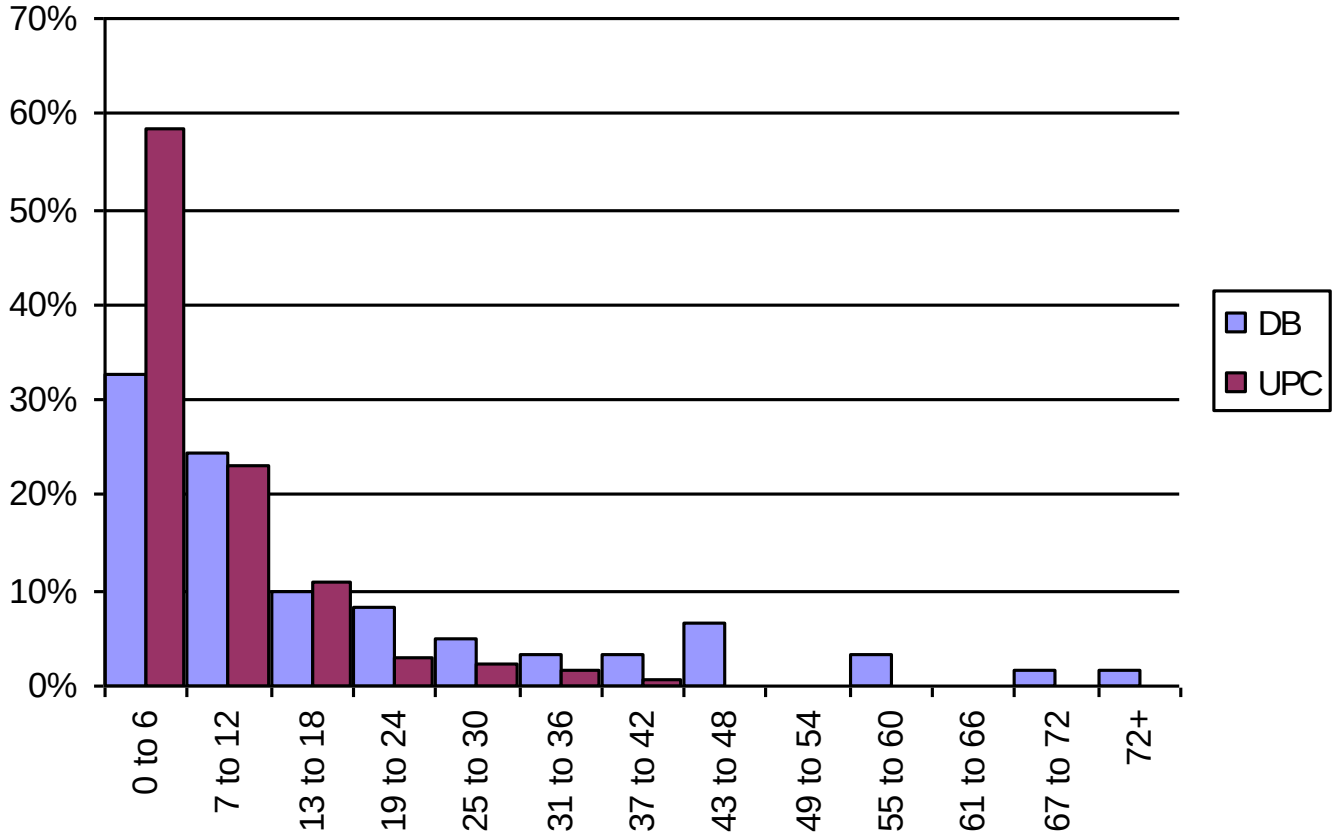
Number of projects, in groups of Million SEK:



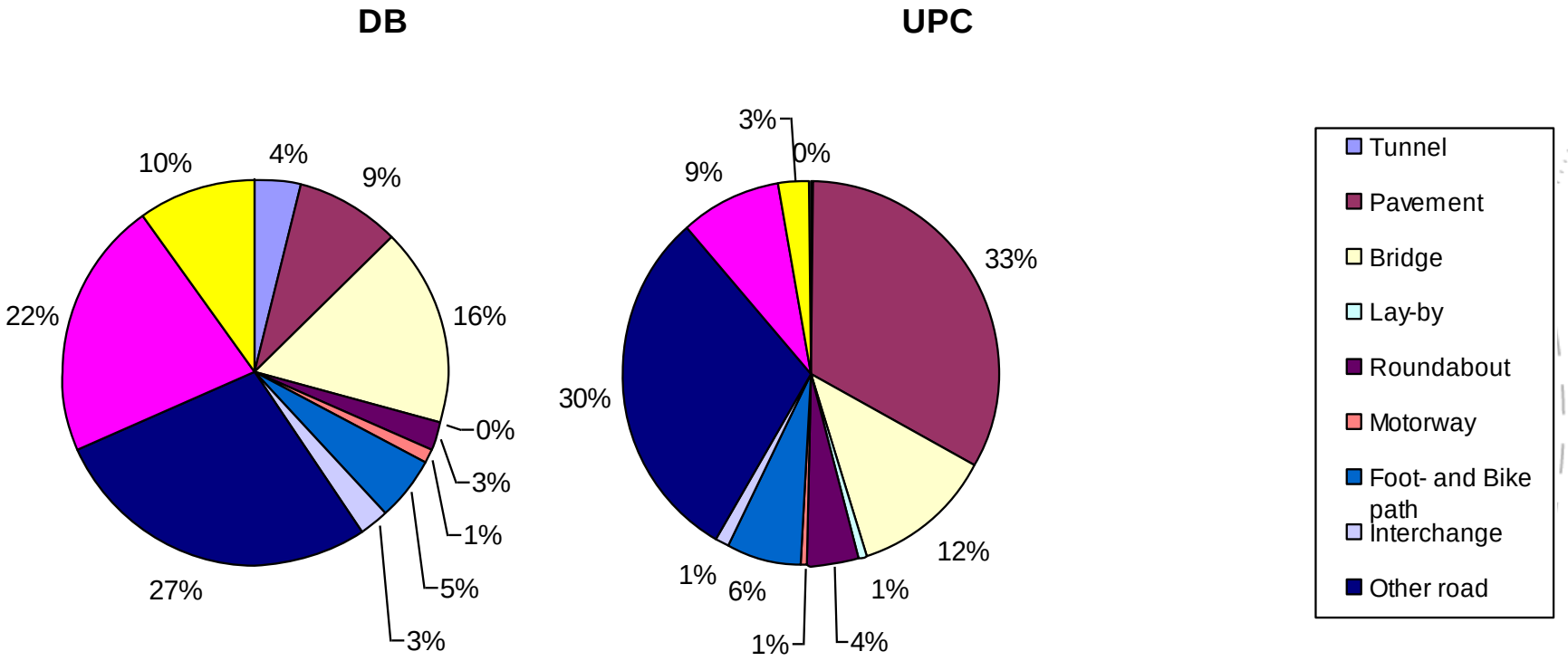
DB and UPC used for different projects (2)

Difference in expected duration

Number of projects, in groups of duration [months]



DB and UPC used for different projects (3)



”Minor” projects – e.g., bus stops, intersections, bridges for bicycling – much less common under DB.

May support the idea about more complex projects procured through DB

Other conjectures

Regarding design, risk aversion, common risk level of project etc. impossible to say anything at this stage

Regarding number of agents:

No apparent trend

On average 3.3 in DB compared to 4.3 in UPC

Possibly supporting the idea of limiting total design costs – but that is stretching things very far…

Conclusions

DB has obvious merits in giving the agent the right to design a project and decide how it is to be built.

But there are many circumstances where it too costly to let the agent take all risk and where UPC may be preferred

Our review has generated a ceteris paribus set of guidelines for when one is to be preferred before the other.

Some evidence from data regarding systematic differences in when DB or UPC is used supporting our main idea