

Asphalt compared to Concrete for Highways

An Exploration of Discounted Cash Flow Analysis in Practice

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Basic Practical Issue: Which Technology?

- **Technologies often differ in Pattern of Cash Flows**
- **A typical structure:**
 - One may cost more, but save money, last longer
 - Another may be cheaper immediately, but cost more to operate, fail earlier
- **Let's look at a practical example**

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Choice of Highway Pavement: Asphalt or Concrete

- **Concrete lasts longer -- is more expensive**
- **Asphalt less expensive to place, but fails earlier**
- **Both pavements eventually have to be resurfaced - typically with an asphalt coat**
- **Which is better?**

What is Life of Technology?

- **What is the “life” of equipment?**
- **At what point does it fail or “die”?**
- **Consider ‘statistical’ Analysis of US Experience, 1920-1950s**
 - **Life of Asphalt ~ 17 years**
 - **Life of Concrete ~ 27 years**
- **Can we believe this?**

Examination of Data on Highway Life

- **1920s -- Boom Period -**
 - Concrete highways
- **1930s -- Depression**
 - Asphalt highways
- **1940s -- War**
 - “Nothing” built
- **1950s -- Reconstruction**
 - Average age of concrete: 27 = 1952 - 1925
 - Average age of asphalt: 17 = 1952 - 1935

Example Analysis

- **Assumed Numbers**
 - Asphalt costs 1000/unit initially
 - Concrete costs 20% more, 1200
 - Cost of Resurfacing is 400 for each
- **See Example**

Excel Set up for Analysis

Year	Asphalt	Concrete			
0	1000	1200	21	0	0
1	0	0	22	0	0
2	0	0	23	0	0
3	0	0	24	0	0
4	0	0	25	0	0
5	0	0	26	0	0
6	0	0	27	0	400
7	0	0	28	0	0
8	0	0	29	0	0
9	0	0	30	0	0
10	0	0	31	0	0
11	0	0	32	0	0
12	0	0	33	0	0
13	0	0	34	400	0
14	0	0	35	0	0
15	0	0	36	0	0
16	0	0	37	0	0
17	400	0	38	0	0
18	0	0	39	0	0
19	0	0	40	0	0
20	0	0			

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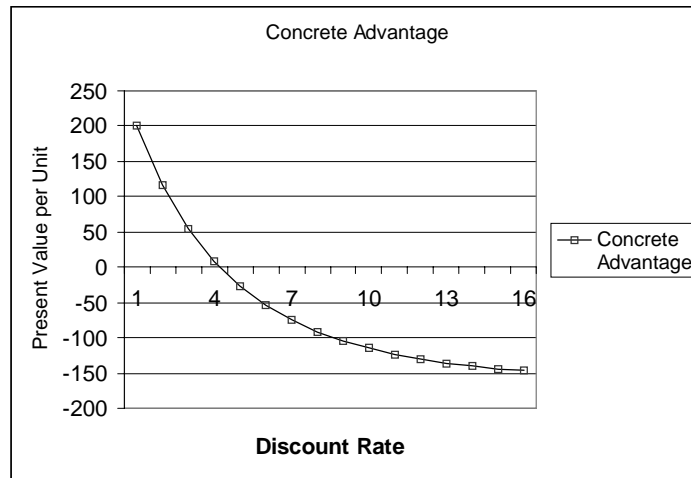
Cost Advantage of Concrete (Table)

	Base Case		Delta
	-995	-1,119	
0%	-1800	-1600	200
1%	-1607	-1491	116
2%	-1460	-1406	54
3%	-1348	-1340	8
4%	-1260	-1287	-27
5%	-1191	-1245	-54
6%	-1136	-1210	-75
7%	-1090	-1182	-91
8%	-1053	-1157	-104
9%	-1022	-1137	-115
10%	-995	-1119	-123
11%	-972	-1103	-130
12%	-952	-1088	-136
13%	-935	-1075	-140
14%	-919	-1063	-144
15%	-905	-1051	-147

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Cost Advantage of Concrete (Chart)



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Lesson from Comparison

- **Choice of Technology may depend on choice of discount rate**
- **Those who determine Choice of Discount Rate may be true designers**
- **Why was most of US Interstate Highway System built of concrete?**
- **but privately financed toll roads (such as Mass Pike) were not?**

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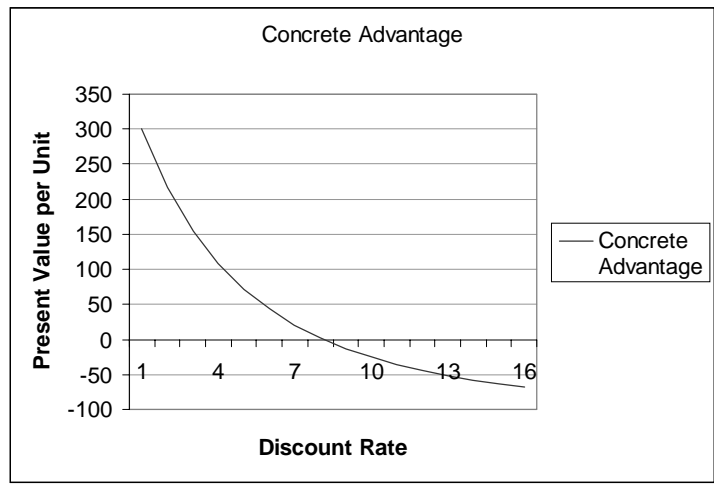
Effect of Investment Subsidies (payments or tax credits)

50 % Subsidy of Initial Costs			
	-595	-631	Delta
0%	-1300	-1000	300
1%	-1123	-906	217
2%	-990	-834	155
3%	-888	-780	108
4%	-811	-739	72
5%	-751	-707	44
6%	-704	-683	21
7%	-667	-664	2
8%	-637	-650	-13
9%	-614	-639	-25
10%	-595	-631	-36
11%	-579	-624	-45
12%	-567	-619	-52
13%	-556	-615	-58
14%	-548	-612	-64
15%	-541	-609	-69

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Cost Advantage of Concrete (with 50% subsidy)



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Lesson of Effect of Subsidy

- Policies that affect only part of the cash flow, affect the relative merits of alternative technologies.
- Subsidies on Construction costs favor more expensive investments
- US Government pays States up to 90% of initial investment for Interstates
- This is a major reason why Interstate System is built in concrete....

Importance of Life of Project (20 versus 40 highway life)

Effect of Considering only 20 years

	-981	-1091	Delta (A)	Delta (C)
0%	-1400	-1200	-22%	-25%
1%	-1325	-1188	-18%	-20%
2%	-1260	-1176	-14%	-16%
3%	-1206	-1165	-11%	-13%
4%	-1159	-1154	-8%	-10%
5%	-1119	-1143	-6%	-8%
6%	-1084	-1132	-5%	-6%
7%	-1053	-1121	-3%	-5%
8%	-1026	-1111	-3%	-4%
9%	-1002	-1101	-2%	-3%
10%	-981	-1091	-1%	-2%
11%	-962	-1081	-1%	-2%
12%	-945	-1071	-1%	-2%
13%	-929	-1062	-1%	-1%
14%	-915	-1053	0%	-1%
15%	-902	-1043	0%	-1%

Lesson from alternative life of projects

- **Using higher discount rates makes events in distant future insignificant**
- **Cut life of project in half (in example) changes Present value by a few percent**
 - not significant in terms of accuracy of forecast estimates of costs, benefits

Lessons from Example

- **Analyses simple, HOWEVER**
- **Results depend highly on assumptions**
 - About discount rate
 - About tax or subsidy incentives
 - Even about life of project
- **Designers of Tax, Economic Programs may be actual System Designers**