

CHAPTER 5 FINANCIAL ANALYSES OF THE RESULTS FROM THE MODEL

INTRODUCTION

The results in the previous chapter were obtained from analysis of the time taken to carry out each operation (Standard Minutes per Cubic Metre) included in the model. These values were used to examine the effect of several management variables (machine type, harvest system, group size, age at start of transformation, length of transformation period etc.) on the time to carry out operations in even-aged and uneven-aged forests. The aim of this chapter is to use the previous results to carry out financial analyses and to examine the management implications of the two systems. The main questions to be answered are:

1. What does uneven-aged management cost vis-à-vis even-aged management?
2. What are the cost implications of varying group size?
3. Is there a financial optimum age to begin the transformation of an even-aged forest?
4. Is there a financial penalty incurred if transformation is carried out over a longer period?
5. How is the profitability of each system affected by choice of discount rate, Yield Class, and planting grants?

The following results and discussion are based on the model results for the shortwood harvesting system. A corresponding set of figures for pole-length harvesting is not shown because the results for skidder extraction did not show a tendency to increase as the group size decreased and there would not, therefore, be a relationship between group size and Net Present Value.

The calculations carried out to find the optimum age to begin transformation are presented first, because the maximum Net Present Value obtained at the optimum age was then used in the comparisons of even-aged and uneven-aged management.

5.1 CALCULATION OF COSTS AND REVENUES

The output from the model consists of the following values:

1. The time to carry out each operation during each felling period (expressed in Standard Minutes per Cubic Metre)
2. The cost of the operation (machine costs and labour costs)
3. The total volume of wood removed during each felling period
4. Pulpwood and sawlog revenues

The user of the model is prompted to enter values for machine and labour costs (in pence per Standard Minute) and the roadside prices of pulpwood and sawlogs (in pounds per cubic metre). Total costs and revenues are then calculated within the model, by simply multiplying the total operation time by the machine and labour costs and multiplying the pulpwood and sawlog volumes by pulpwood price and sawlog price respectively.

Calculation of Net Present Values was not carried out within the model, because it would have been inefficient to run the whole model in order to investigate the effects of altering the discount rate, for example. Therefore, Net Present Values were calculated using the **EXCEL** spreadsheet package. Once the cash flows have been entered into the spreadsheet programme, variables such as the number of years for discounting and the discount rate may be changed easily and new Net Present Values are calculated almost instantly.

Net Present Values were calculated for discount rates of **3%, 5%, and 7%**. This range of discount rates was chosen to cover the range of values normally associated with forestry investments.

The relevant costs and prices used in the following financial analyses have been derived from Forestry Commission data and the economic surveys of private forestry in England and Wales and are presented below:

Labour Costs (felling and planting): **6.7** p/S.Min

Machine Cost (10-tonne forwarder): 80.0 p/S.Min (includes cost of operator)

Pulpwood price: £15.00/ Cubic Metre (at roadside)

Sawlog price: £29.00/ Cubic Metre (at roadside)

One of the assumptions used in the analyses is the number of years of weeding and/or beating up needed and the cost of such operations. Beating up is carried out one year after planting and weeding operations carried out according to the following schedule, based on the assumption that higher Yield Class sites will require more weeding:

Yield Class 8: One year after planting

Yield Class 12: Two years after planting

Yield Class 16: Three years after planting

Yield Class 20: Four years after planting

It may be that the unit cost of these operations should be slightly higher in an uneven-aged forest than in an even-aged forest, but the difference is thought to be small and average values from the Economic Survey of Private Forestry in England and Wales (1988) were used based on small-scale even-aged management. These are the best data available.

The age chosen for clearfelling the even-aged forest was that of peak MAI; for Sitka spruce this gives ages of 65,55, and 50 for Yield Class 8, 12,20 respectively.

5.2 THE OPTIMUM AGE TO BEGIN TRANSFORMATION

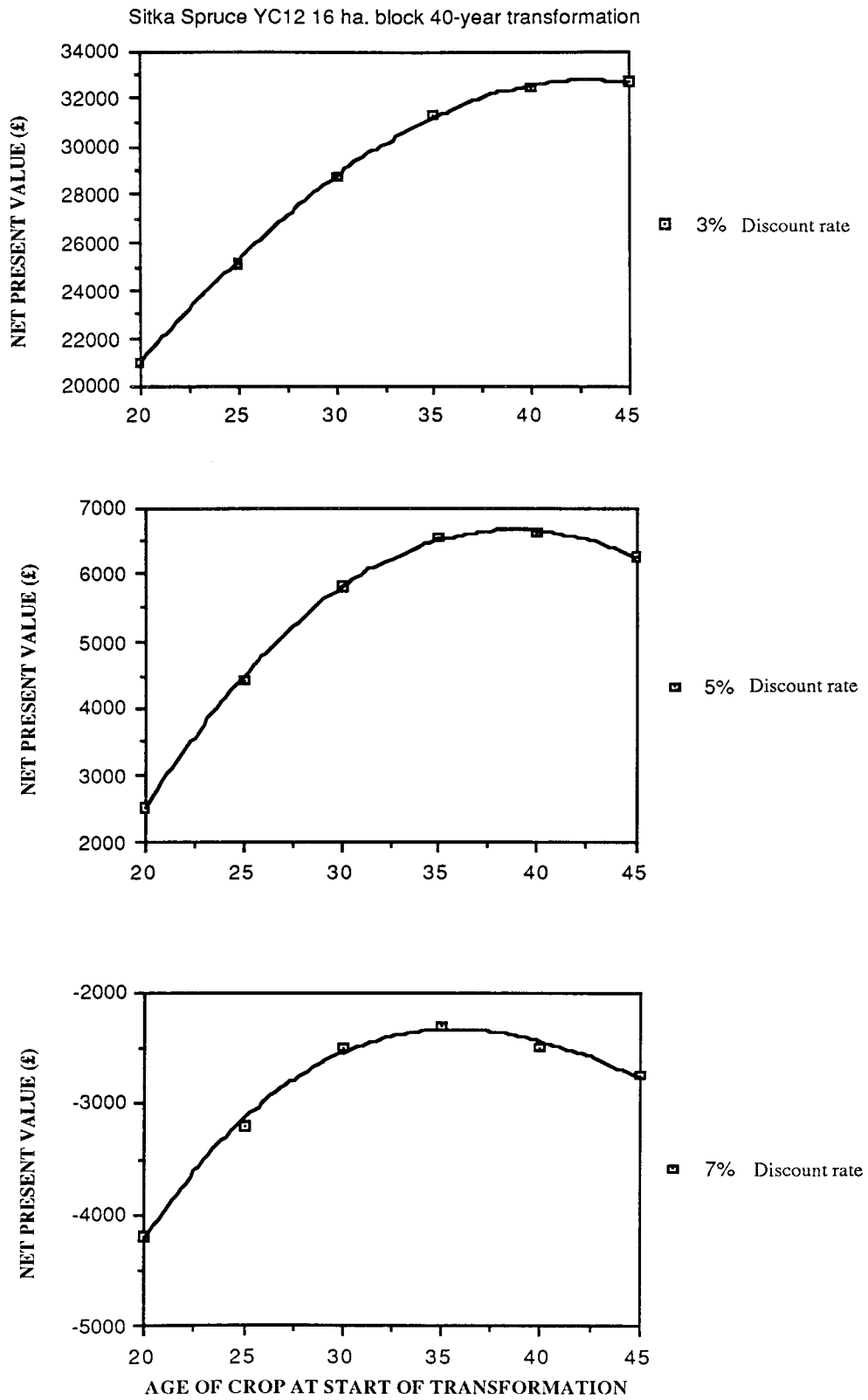
The spreadsheet for the Sitka spruce Yield Class 12 baseline example is shown in Table 5.1. The values presented in the table are for extraction by 10-tonne forwarder on a 16 hectare block and with a 40-year transformation period. The Net Present Values for a range of starting ages are then summarized in Figure 5.1.

In order to find the optimum age for the start of the transformation it was not necessary to project the cash flows to infinity. It was, in fact, not necessary to project them any further than 80 years because this is the age when each of the starting age options has been transformed. After this point, the Net Present Value of each starting age increases by the same amount in each felling period and the difference in Net Present Values between each starting age does not change.

TABLE 5.1: SPREADSHEET SHOWING CASHFLOWS AND PRESENT VALUES FOR THE YC 12 EXAMPLE

YC	40	Ir	start	Disc	Disc	Disc	start	Disc	Disc	Disc	start	Disc	Disc	Disc	start	Disc	Disc	Disc	start	Disc	Disc	Disc				
12	block	CASH	at	3%	at	5%	at	7%	at	3%	at	5%	at	7%	at	3%	at	5%	at	3%	at	5%	at			
YR	OPS	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	
0	plant	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467
1	w./b.u.	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440
2	w./b.u.	-1120	-1056	-1016	-978	-1120	-1056	-1016	-978	-1120	-1056	-1016	-978	-1120	-1056	-1016	-978	-1120	-1056	-1016	-978	-1120	-1056	-1016	-978	-1120
20	extract	-870	-371	-253	-173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	lell	-1368	-787	-618	-354	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	replam	-879	-487	-331	-227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	pulp £	1940	1074	731	501	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	saw £	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	w./b.u.	-180	-97	-65	-43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	w./b.u.	-140	-73	-48	-32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Extract	-3835	-1832	-1132	-707	-4265	-2037	-1259	-788	-3134	-1497	-925	-577	-3134	-1497	-925	-577	-3134	-1497	-925	-577	-3134	-1497	-925	-577	-3134
25	lell	-8736	-2740	-1694	-1057	-6077	-2902	-1795	-1120	-5401	-2580	-1595	-995	-5401	-2580	-1595	-995	-5401	-2580	-1595	-995	-5401	-2580	-1595	-995	-5401
25	replam	-879	-420	-260	-162	-879	-420	-260	-162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	pulp £	11319	5408	3343	2086	12554	5996	3707	2313	10080	4814	2977	1857	10080	4814	2977	1857	10080	4814	2977	1857	10080	4814	2977	1857	10080
25	saw £	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	w./b.u.	-180	-83	-51	-31	-180	-83	-51	-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	w./b.u.	-140	-63	-37	-23	-140	-63	-37	-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Extract	-3875	-1596	-897	-509	-4325	-1782	-1001	-588	-4758	-1980	-1101	-625	-3408	-1404	-789	-448	-3408	-1404	-789	-448	-3408	-1404	-789	-448	-3408
30	lell	-3655	-1506	-846	-480	-3948	-1627	-913	-519	-4368	-1800	-1011	-574	-3595	-1481	-832	-472	-3595	-1481	-832	-472	-3595	-1481	-832	-472	-3595
30	replam	-879	-362	-203	-115	-879	-362	-203	-115	-879	-362	-203	-115	0	0	0	0	0	0	0	0	0	0	0	0	0
30	pulp £	8379	3452	1939	1101	9408	3876	2177	1236	10437	4300	2415	1371	8400	3461	1944	1103	8400	3461	1944	1103	8400	3461	1944	1103	8400
30	saw £	5570	2295	1289	732	5968	2459	1381	784	6366	2623	1473	836	3248	1338	752	427	3248	1338	752	427	3248	1338	752	427	3248
31	w./b.u.	-180	-72	-40	-22	-180	-72	-40	-22	-180	-72	-40	-22	0	0	0	0	0	0	0	0	0	0	0	0	0
32	w./b.u.	-140	-54	-29	-16	-140	-54	-29	-16	-140	-54	-29	-16	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Extract	-3618	-1288	-656	-339	-4052	-1440	-735	-380	-4489	-1595	-814	-420	-4934	-1753	-894	-462	-3391	-1205	-615	-318	-2557	-909	-464	-239	-2557
35	lell	-2546	-905	-462	-238	-2784	-989	-505	-261	-3097	-1101	-561	-290	-3392	-1205	-615	-318	-2557	-909	-464	-239	-2557	-909	-464	-239	-2557
35	replam	-879	-312	-159	-82	-879	-312	-159	-82	-879	-312	-159	-82	0	0	0	0	0	0	0	0	0	0	0	0	0
35	pulp £	4998	1776	906	468	5704	2027	1034	534	6409	2278	1162	600	7115	2529	1290	666	5780	2047	1044	539	5760	2047	1044	539	5760
35	saw £	12905	4444	2267	1171	13528	4968	2452	1267	14551	5171	2638	1363	15574	5535	2823	1459	8352	2968	1514	782	8352	2968	1514	782	8352
36	w./b.u.	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	-180
37	w./b.u.	-140	-47	-23	-11	-140	-47	-23	-11	-140	-47	-23	-11	-140	-47	-23	-11	-140	-47	-23	-11	-140	-47	-23	-11	-140
40	Extract	-3484	-1068	-495	-233	-3967	-1216	-563	-285	-4417	-1354	-627	-295	-4873	-1494	-692	-325	-5333	-1635	-758	-356	-3550	-1088	-504	-237	-3550
40	lell	-1927	-591	-274	-129	-2125	-651	-302	-142	-2374	-728	-337	-159	-2619	-803	-372	-175	-2840	-871	-403	-190	-1992	-611	-283	-133	-1992
40	replam	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	-879
40	pulp £	2793	856	397	187	3205	983	455	214	3616	1109	514	241	4028	1235	572	269	4439	1361	631	296	5000	1533	710	334	5000
40	saw £	17279	5297	2454	1154	18871	5785	2681	1260	20462	6273	2907	1366	22054	6761	3133	1473	23645	7249	3359	1579	11352	3480	1613	758	11352
41	w./b.u.	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	-180
42	w./b.u.	-140	-40	-18	-8	-140	-40	-18	-8	-140	-40	-18	-8	-140	-40	-18	-8	-140	-40	-18	-8	-140	-40	-18	-8	-140
45	Extract	-3778	-999	-420	-180	-3804	-1006	-423	-181	-4268	-1129	-475	-203	-4721	-1248	-525	-225	-5174	-1368	-576	-246	-5630	-1489	-627	-268	-5630
45	lell	-2193	-580	-244	-104	-1678	-444	-187	-80	-1886	-499	-210	-90	-2088	-552	-232	-99	-2291	-606	-255	-109	-2471	-653	-275	-118	-2471
45	replam	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	-879
45	pulp £	3028	801	337	144	2117	560	236	101	2440	645	272	116	2764	731	308	132	3087	816	344	147	3410	902	380	162	3410
45	saw £	19496	5155	2170	928	21258	5621	2368	1012	23020	6087	2562	1096	24782	6553	2758	1180	26544	7019	2954	1264	28306	3665	1350	1348	28306
46	w./b.u.	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	-180
47	w./b.u.	-140	-35	-14	-6	-140	-35	-14	-6	-140	-35	-14	-6	-140	-35	-14	-6	-140	-35	-14	-6	-140	-35	-14	-6	-140
50	Extract	-4000	-912	-349	-136	-4006	-914	-349	-136	-4019	-917	-350	-136	-4458	-1017	-389	-151	-4901	-1118	-427	-166	-5325	-1215	-484	-181	-5325
50	lell	-2337	-533	-204	-79	-1999	-456	-174	-68	-1521	-347	-133	-52	-1684	-384	-147	-57	-1853	-412	-162	-63	-2019	-461	-176	-69	-2019
50	replam	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	-879
50	pulp £	3381	771	295	115	2528	577	220	86	1470	335	128	50	1646	375	144	56	1823</								

Figure 5.1: Net Present Values for a Range of Starting Ages



It is easy to comprehend why it is not sensible to begin the transformation too early. In this example, at age 20 the trees have not even reached the age of first thinning and the harvesting operations carried out during the first felling period actually incur a loss. Then, for much of the remainder of the transformation period trees are being harvested before they are mature and the sawlog revenues are low throughout the transformation.

However, it is also possible to delay the start of the transformation too long. If the transformation is delayed, the lower revenues in the early years (obtained from carrying out only thinnings) are never recouped when subsequent revenues are discounted, even when the large trees are harvested towards the end of the transformation. As these trees reach peak MAI the net revenues from the different starting ages begin to merge because the rate of increase in value of the residual trees begins to decrease. The values for the net cash flows, shown in Table 5.2, help to illustrate this.

Table 5.2: Net Cash Flows for the Baseline example

Year	Start 20	Start 25	Start 30	Start 35	Start 40	Start 45
0	-6467	-6467	-6467	-6467	-6467	-6467
1	-1440	-1440	-1440	-1440	-1440	-1440
2	-1120	-1120	-1120	-1120	-1120	-1120
20	-1023	0	0	0	0	0
25	869	1333	1545	1545	1545	1545
30	5540	6224	6798	4645	4645	4645
35	10460	11517	12515	13484	8164	8164
40	13782	15105	16408	17711	19032	10810
45	15676	17014	18427	19858	21287	22736
50	17082	18096	20155	20942	22439	23958
55	18811	19282	20087	21251	22639	23992
60	11542	20387	20605	21217	21300	23415
65	11542	11542	21671	21828	22336	23217
70	11542	11542	11542	22960	23049	23516
75	11542	11542	11542	11542	23950	23937
80	11542	11542	11542	11542	11542	24722
85	11542	11542	11542	11542	11542	11542

From figure 5.1, it can be seen that as the applied discount rate increases, the optimum age to begin the transformation decreases. This again follows from the argument in the previous section: the discounted values of the later fellings are less likely to make up for the low early revenues obtained from thinning only and this phenomenon is exaggerated with higher discount rates. At a discount rate of 3%, the optimum age to begin transformation is around age 45, whereas at a discount rate of 7%, transformation should, ideally, begin around age 35.

Figures 5.2 and 5.3 summarize the Net Present Values for the higher and lower Yield Class examples (see spreadsheets in Tables 5.3 and 5.4 for the full values). The optimum starting ages follow the same relationship with the discount rate as described above. i.e. at lower discount rates the optimum age for the start of transformation is later. However, the optimum starting age for the higher Yield Class example is significantly earlier than that of the baseline example for each discount rate. The optimum age is approximately 35 years for the 3% discount rate and 28 years for the 7% discount rate. Delaying the start of the transformation on the higher Yield Class site incurs a higher financial penalty because MAI peaks earlier and thinning volumes taken out after peak MAI decrease significantly. As the transformation is delayed, a greater proportion of the volume removed during any one felling period is obtained from thinnings and this therefore has an impact on net revenues. Conversely, on the Yield Class 8 site where MAI peaks later and thinning volumes do not drop so dramatically, transformation may be delayed to age 40 (7% discount rate) or even beyond age 45 (3% discount rate).

Although almost all the graphs in these three figures (with the exception of the YC 8 example at a discount rate of 3%) show a clear peak, the peak is generally not very sharp. This means that starting the transformation at ages either side of the optimum will not lead to great losses. In fact, starting the transformation within five years either side of the optimum age gives Net Present Values within approximately 5% of the maximum (obtained when starting the transformation at the optimum age).

Figure 5.2: Net Present Values for a Range of Starting Ages

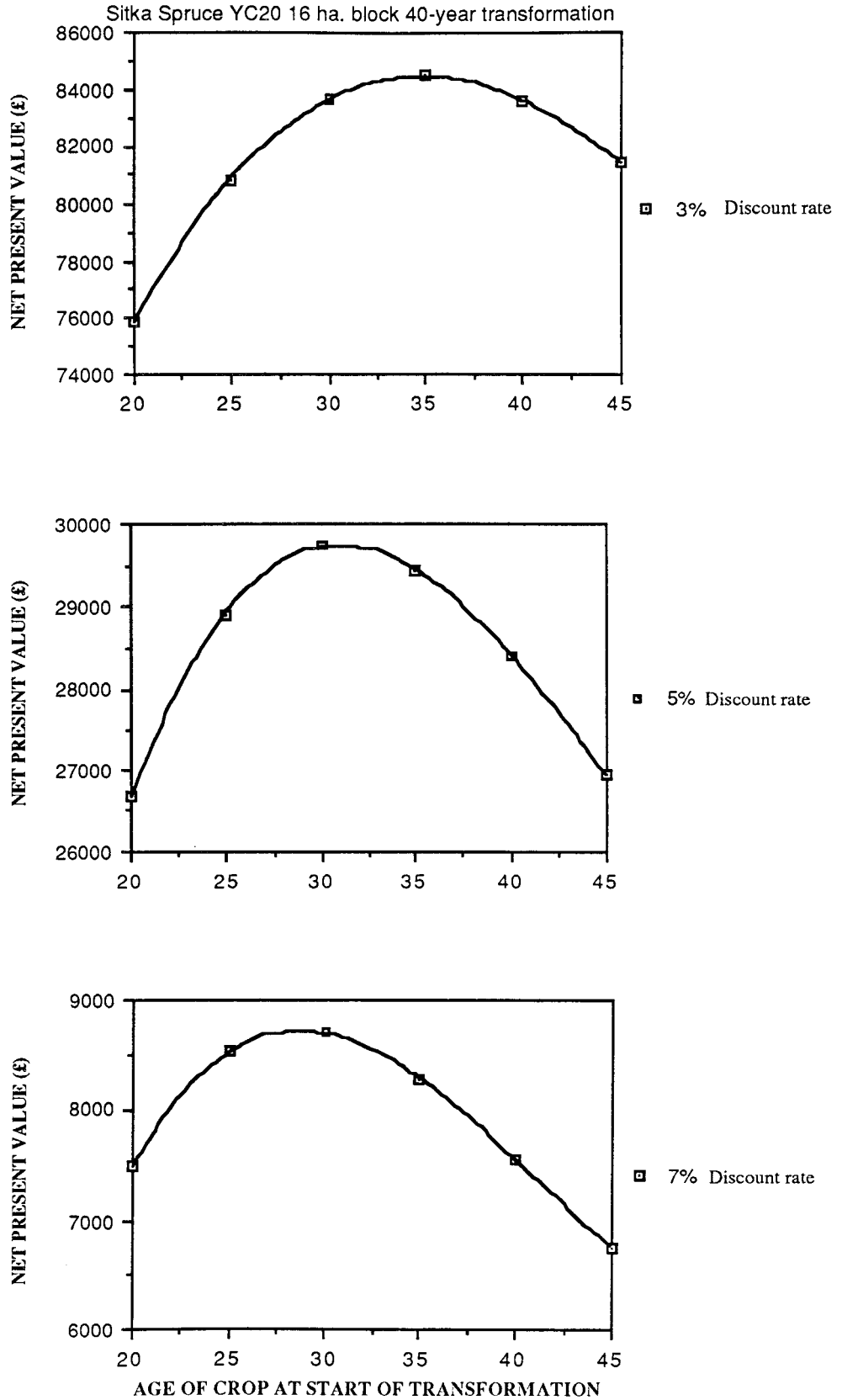


TABLE 5.4: SPREADSHEET SHOWING CASHFLOWS AND PRESENT VALUES FOR THE YC 8 EXAMPLE

SS	40	tr	start	disc	disc	disc	Start	disc	disc	disc	Start	disc	disc	disc	Start	disc	disc	disc	Start	disc	disc	disc	Start	disc	disc	disc
YC	16	ha	20	disc	disc	disc	25	disc	disc	disc	30	disc	disc	disc	35	disc	disc	disc	40	disc	disc	disc	45	disc	disc	disc
8	block	CASH	at	at	at	CASH	at	at	at	CASH	at	at	at	CASH	at	at	at	CASH	at	at	at	CASH	at	at	at	at
YR	OPS	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	FLOW	3%	5%	7%	
0	plant	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467
1	w/b.u	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440	-1398	-1371	-1346	-1440
20	extrac	-493	-273	-186	-127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	fell	-1129	-625	-426	-292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	replant	-879	-487	-331	-227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	pulp £	1411	781	532	365	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	saw £	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	w/b.u	-180	-97	-65	-43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	extrac	-647	-309	-191	-119	-647	-309	-191	-119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	fell	-1285	-614	-379	-237	-1283	-613	-379	-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	replant	-879	-420	-260	-162	-879	-420	-260	-162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	pulp £	1852	885	547	341	1852	885	547	341	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	saw £	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	w/b.u	-180	-83	-51	-31	-180	-83	-51	-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	extrac	-2531	-1043	-588	-332	-2795	-1152	-647	-367	-3081	-1269	-713	-405	-2087	-860	-483	-274	-2087	-860	-483	-274	-2087	-860	-483	-274	
30	fell	-3605	-1485	-834	-474	-4043	-1666	-935	-531	-4428	-1824	-1025	-582	-3323	-1369	-769	-437	-3323	-1369	-769	-437	-3323	-1369	-769	-437	
30	replant	-879	-362	-203	-115	-879	-362	-203	-115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	pulp £	7379	3040	1707	989	8202	3379	1898	1077	9026	3719	2088	1186	6720	2769	1555	883	6720	2769	1555	883	6720	2769	1555	883	
30	saw £	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	w/b.u	-180	-72	-40	-22	-180	-72	-40	-22	-180	-72	-40	-22	-180	-72	-40	-22	-180	-72	-40	-22	-180	-72	-40	-22	
35	extrac	-2539	-902	-460	-238	-2815	-1000	-510	-264	-3067	-1090	-556	-287	-3355	-1192	-608	-314	-2087	-742	-378	-195	-2087	-742	-378	-195	
35	fell	-2769	-991	-506	-261	-3142	-1117	-570	-294	-3495	-1242	-634	-327	-3833	-1362	-695	-359	-2804	-996	-508	-263	-2804	-996	-508	-263	
35	replant	-879	-312	-159	-82	-879	-312	-159	-82	-879	-312	-159	-82	-879	-312	-159	-82	0	0	0	0	0	0	0	0	0
35	pulp £	6644	2361	1204	622	7468	2654	1354	699	8291	2948	1503	777	9114	3239	1852	854	8720	2388	1218	629	8720	2388	1218	629	
35	saw £	1535	546	278	144	1535	546	278	144	1535	546	278	144	1535	546	278	144	0	0	0	0	0	0	0	0	0
36	w/b.u	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	-180	-62	-31	-16	0	0	0	0	0	0	0	0	0
40	extrac	-2590	-794	-388	-173	-2914	-893	-414	-195	-3221	-987	-458	-215	-3527	-1081	-501	-236	-3831	-1174	-544	-256	-2336	-716	-332	-156	
40	fell	-2135	-654	-303	-143	-2411	-739	-342	-161	-2668	-818	-379	-178	-2964	-909	-421	-198	-3224	-988	-458	-215	-2195	-673	-312	-147	
40	replant	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	-879	-269	-125	-59	0	0	0	0	0	0	0	0	0
40	pulp £	4939	1514	702	330	5845	1731	802	377	6350	1947	902	424	7006	2148	995	488	7782	2379	1103	518	8760	1766	818	385	
40	saw £	5286	1620	751	353	5513	1690	783	368	5741	1760	815	383	5988	1830	848	399	6196	1899	880	414	1856	569	264	124	
41	w/b.u	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	-180	-54	-24	-11	0	0	0	0	0	0	0	0	0
45	extrac	-2366	-626	-263	-113	-2682	-709	-298	-128	-3002	-794	-334	-143	-3304	-874	-368	-157	-3626	-959	-404	-173	-3938	-1041	-438	-188	
45	fell	-1697	-449	-189	-81	-1929	-510	-215	-92	-2158	-571	-240	-103	-2387	-631	-266	-114	-2617	-692	-291	-125	-2826	-747	-315	-135	
45	replant	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	-879	-232	-98	-42	0	0	0	0	0	0	0	0	0
45	pulp £	3528	933	393	168	4087	1081	455	195	4645	1228	517	221	5204	1376	579	248	5782	1524	641	274	6321	1672	704	301	
45	saw £	8469	2240	943	403	8981	2375	1000	428	9492	2510	1056	452	10004	2645	1113	476	10515	2781	1170	501	11027	2916	1227	525	
46	w/b.u	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	-180	-46	-19	-8	0	0	0	0	0	0	0	0	0
50	extrac	-2552	-826	-223	-87	-2581	-569	-225	-88	-2898	-661	-253	-98	-3211	-732	-280	-109	-3510	-801	-306	-119	-3824	-872	-333	-130	
50	fell	-1805	-412	-157	-61	-1583	-361	-138	-54	-1779	-406	-155	-60	-1974	-450	-172	-67	-2169	-495	-189	-74	-2363	-509	-206	-80	
50	replant	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	-879	-201	-77	-30	0	0	0	0	0	0	0	0	0
50	pulp £	2940	871	258	100	2528	577	220	86	2940	671	256	100	3352	765	292	114	3763	858	328	128	4175	952	364	142	
50	saw £	11482	2819	1001	390	12277	2800	1071	417	13073	2982	1140	444	13869	3164	1209	471	14665	3345	1279	498	15460	3527	1348	525	
51	w/b.u	-180	-40	-15	-6	-180	-40	-15	-6	-180	-40	-15	-6	-180	-40	-15	-6	0	0	0	0	0	0	0	0	0
55	extrac	-2703	-532	-185	-65	-2704	-532	-185	-65	-2710	-533	-185	-66	-3001	-590	-205	-73	-3287	-647	-225	-80	-3588	-706	-245	-87	
55	fell	-1892	-372	-129	-46	-1696	-334	-116	-41	-1433	-282	-98	-35	-1590	-313	-109	-38	-1742	-343	-119	-42	-1893	-373	-130	-46	
55	replant	-879	-173	-60	-21	-879	-173	-60	-21	-879	-173	-60	-21	-879	-173	-60	-21	0	0	0	0	0	0	0	0	0
55	pulp £	3146	819	215	76	2587	509	177	63	2029	399	139	49	2293	451	157	56	2558	503	175	62	2822	555	193	68	
55	saw £	12618	2483	862	305	13528	2662	924	327	14437	2841	986	349	15347	3020	1049	371	16256	3199	1111	393	17166	3378	1173	415	
56	w/b.u	-180	-34	-12	-4	-180	-34	-12	-4	-180	-34	-12	-4	-180	-34	-12										

Figure 5.3: Net Present Values for a Range of Starting Ages

Sitka Spruce YC8 16 ha. block 40-year transformation

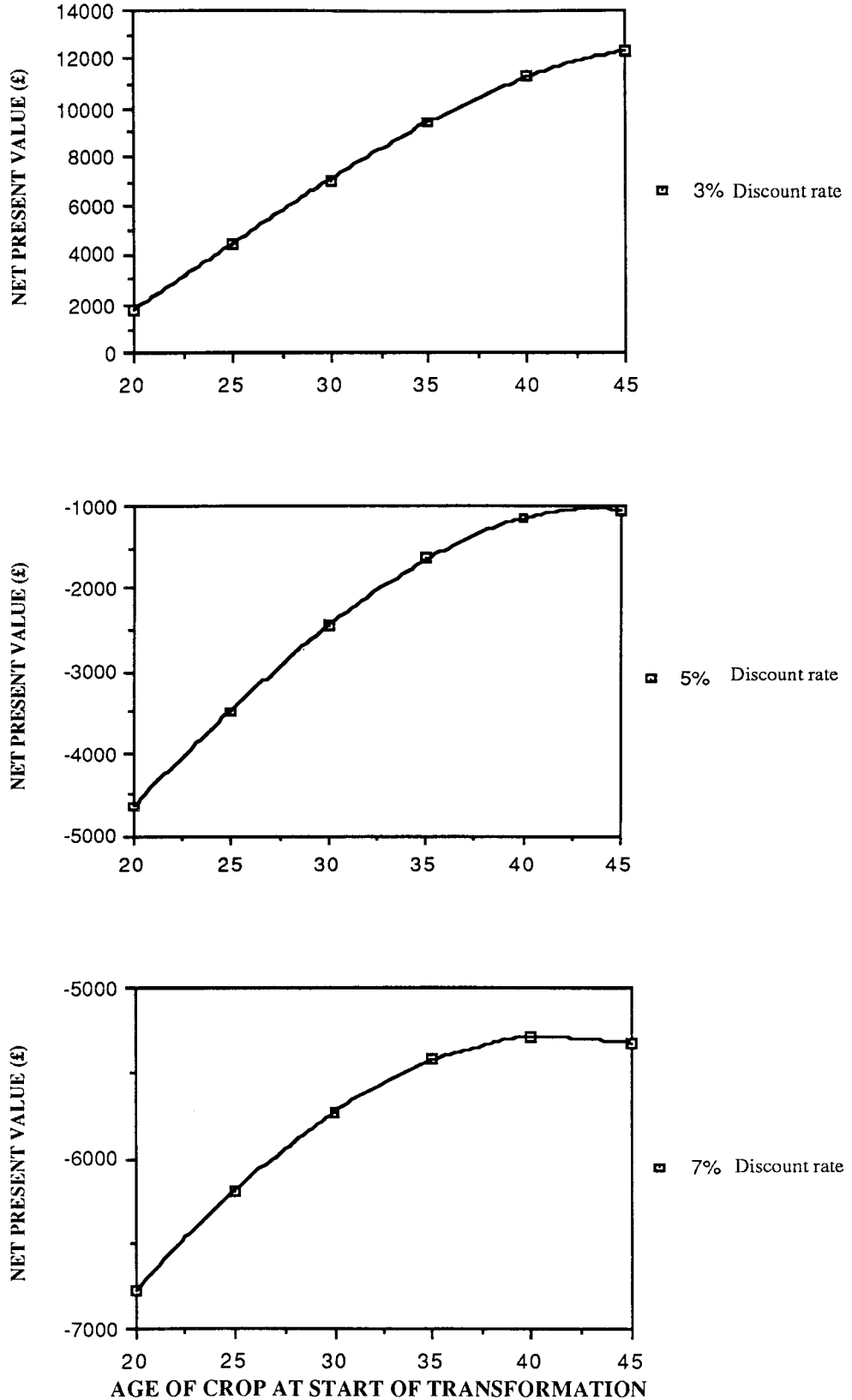
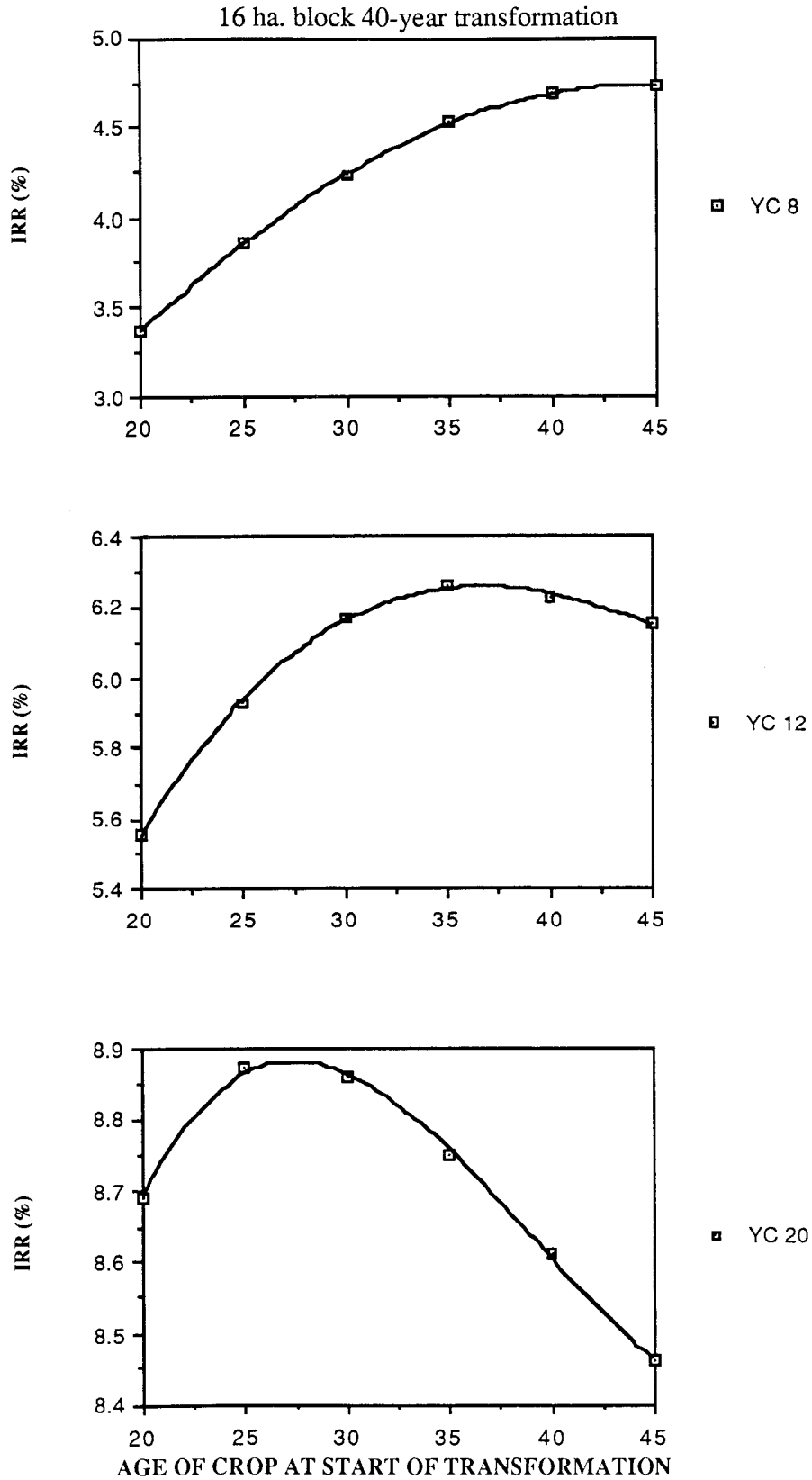


Figure 5.4: Internal Rate of Return for a Range of Starting Ages



5.2.1 INTERNAL RATE OF RETURN

Although the Internal Rate of Return is not the best criterion to use to choose between investments, because of the problem of multiple roots and the inappropriate discount rate problem (Price, 1989) I have included the corresponding IRR's for the range of Yield Classes and starting ages (See Figure 5.4), because the Internal Rate of Return for each Yield Class shows a clear peak which correspond to the peaks in Net Present Value for each Yield Class.

5.3 THE EFFECT OF THE LENGTH OF THE TRANSFORMATION PERIOD ON NET PRESENT VALUES

In the early stages of transformation the net cash flows from the shorter (40-year) transformation period are higher than those from the longer (80-year) transformation period, because a greater proportion of the fellings are final fellings rather than thinnings. Therefore, both the total volume removed and the sawlog volume are higher with the shorter transformation period.

Once the forest is transformed, however, the position is reversed because although the longer transformation period involves half the final felling area of the shorter transformation period, the trees removed during the final fellings are twice as old and far more valuable. Also, with the longer transformation period, much of the thinning volume (once the forest is transformed) is made up of older, larger trees with a corresponding higher proportion of sawlogs. The net cash flows for the two transformation periods, with other variables as for the baseline example, are shown in Figure 5.5.

The Net Present Values (using the same range of discount rates) for the cash flows shown in Figure 5.5 are shown in the following figure (see Figure 5.6).

Unfortunately, the 80-year transformation period could not be investigated as thoroughly as the 40-year transformation period (i.e. examining the effect of later starting ages) because the Yield Tables were only extrapolated to age 105 and, also, it would be unwise to rely heavily on the extrapolated portion of the tables.

Figure 5.5 :Net Cash Flow for two transformation periods
 Sitka spruce, Yield Class 12, 16 ha. block, forwarder extraction

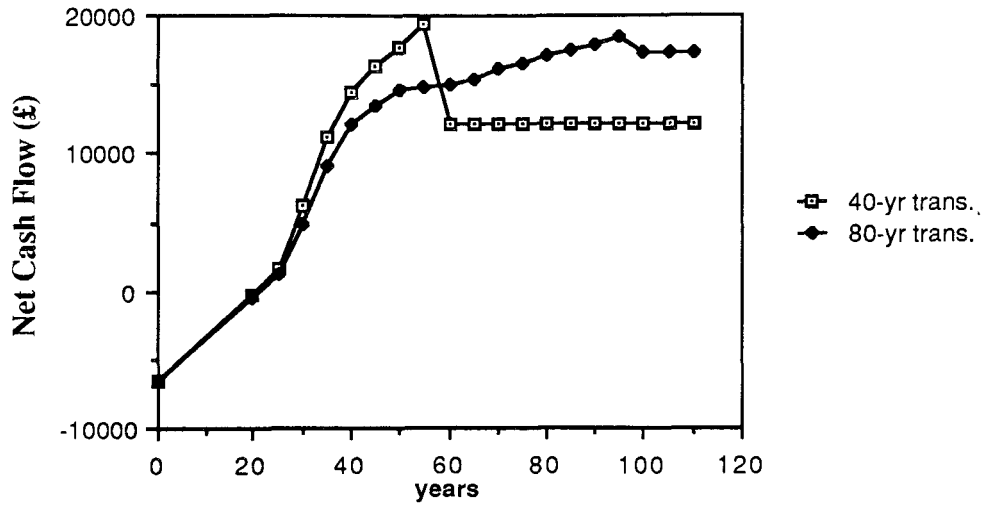
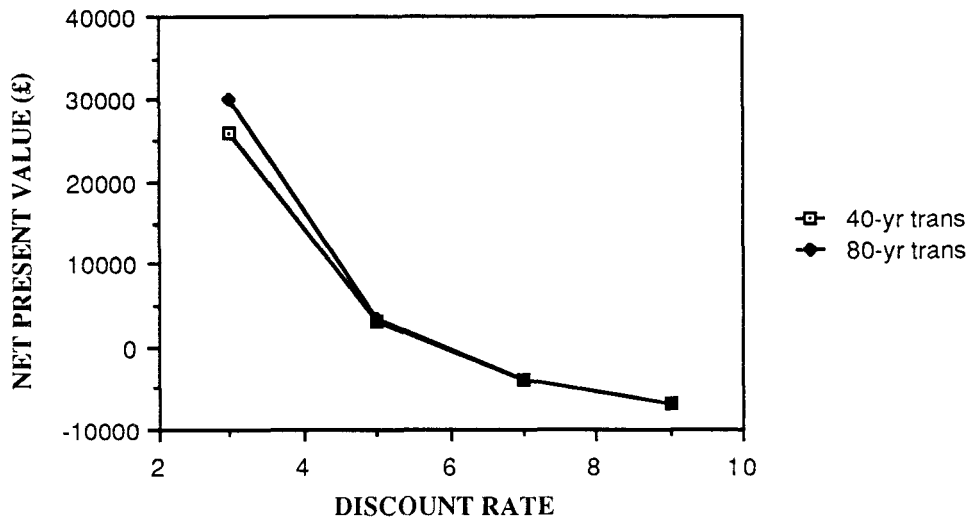


Figure 5.6:Net Present Values for Two Transformation Periods



At low discount rates the longer transformation period is a better investment, because the higher revenues obtained after transformation (from felling and thinning trees which are twice as old) make a large contribution to the Net Present Value. However, as the discount rate increases the Net Present Values for the two transformation periods merge because the revenues obtained after transformation are higher with a longer transformation period, these revenues are so far in the future that they do not compensate for the higher revenues obtained from the shorter transformation period, in the early stages of the transformation.

TABLE 5.5: Spreadsheet showing Cashflows for Clearfelling on 3 Yield Class sites

SS	18 ha block	Discounted	Discounted	Discounted	SS	Discounted	Discounted	Discounted	SS	Discounted	Discounted	Discounted	
YCB1	OPERATION	Gain	3%	5%	7%	Gain	3%	5%	7%	Gain	3%	5%	7%
		at	at	at	at	at	at	at	at	at	at	at	at
0	plant	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467	-6467
1	weed/beat up	-1440	-1398	-1371	-1348	-1440	-1398	-1371	-1348	-1440	-1398	-1371	-1348
2	weed/beat up	-1120	-1058	-1018	-978	-1120	-1058	-1018	-978	-1120	-1058	-1018	-978
3	weed/beat up	-800	-779	-759	-734	-800	-779	-759	-734	-800	-779	-759	-734
4	weed/beat up	-800	-771	-750	-724	-800	-771	-750	-724	-800	-771	-750	-724
20	f.t Extract	-6450	-3018	-2054	-1408	0	0	0	0	0	0	0	0
20	fell	-7821	-4370	-2948	-2021	0	0	0	0	0	0	0	0
20	pulp rev	15120	9372	5889	3902	0	0	0	0	0	0	0	0
20	saw rev	3248	1708	1224	839	0	0	0	0	0	0	0	0
25	f.t Extract	-5388	-2578	-1694	-985	-3124	-1497	-929	-677	0	0	0	0
25	fell	-4018	-1918	-1187	-740	-5401	-2589	-1585	-985	0	0	0	0
25	pulp rev	8800	4585	2835	1789	10080	4814	2877	1857	0	0	0	0
25	saw rev	13820	8648	4111	2565	0	0	0	0	0	0	0	0
30	f.t Extract	-5802	-2308	-1298	-738	-3408	-1404	-789	-448	-2087	-860	-480	-274
30	fell	-2884	-1088	-618	-350	-3595	-1481	-832	-472	-3323	-1389	-769	-437
30	pulp rev	4080	1881	944	528	8400	3481	1944	1109	8720	2788	1658	883
30	saw rev	24592	10132	5880	3231	3248	1338	759	427	0	0	0	0
35	f.t Extract	-4828	-1761	-893	-481	-3291	-1205	-615	-318	-2087	-742	-378	-195
35	fell	-3018	-118	-385	-188	-2557	-909	-484	-238	-2004	-898	-508	-283
35	pulp rev	1920	882	448	180	5780	2047	1044	539	8720	2398	1218	629
35	saw rev	28768	10224	5215	2884	8952	2888	1514	782	0	0	0	0
40	f.t Extract	-4818	-1507	-898	-328	-3550	-1088	-504	-237	-2338	-718	-332	-156
40	fell	-1810	-484	-228	-108	-1882	-611	-289	-133	-2195	-673	-312	-147
40	pulp rev	1200	388	170	80	3380	1030	477	224	5780	1788	818	385
40	saw rev	30180	9248	4284	2014	12882	3883	1845	888	1858	589	264	124
45	f.t Extract	-4825	-1223	-515	-220	-3521	-991	-392	-168	-2395	-893	-487	-218
45	fell	-1254	-332	-140	-60	-1827	-490	-181	-77	-1821	-483	-233	-87
45	pulp rev	720	180	80	36	2840	898	284	126	4580	1208	508	217
45	saw rev	28232	7730	3253	1382	14384	3804	1801	685	4178	1104	485	199
50	f.t Extract	-28440	-8031	-3208	-998	-3254	-785	-282	-114	-2509	-572	-218	-85
50	fell	-8352	-1448	-554	-218	-1918	-300	-115	-45	-1545	-352	-135	-52
50	pulp rev	4320	885	377	147	1440	328	128	49	3380	788	293	114
50	saw rev	255200	58210	22564	8883	15778	3599	1378	538	6486	1482	568	221
50	replant	-6487	-1475	-584	-220	0	0	0	0	0	0	0	0
51	weed/b.up	-1440	-119	-120	-46	0	0	0	0	0	0	0	0
52	weed/b.up	-1120	-241	-89	-29	0	0	0	0	0	0	0	0
53	weed/b.up	-800	-200	-72	-27	0	0	0	0	0	0	0	0
54	weed/b.up	-800	-182	-67	-21	0	0	0	0	0	0	0	0
55	f.t Extract	0	0	0	0	-18818	-3883	-1272	-451	-2728	-458	-159	-58
55	fell	0	0	0	0	-7580	-1488	-517	-193	-1219	-240	-83	-30
55	pulp rev	0	0	0	0	8000	1181	410	145	2180	425	148	52
55	saw rev	0	0	0	0	18824	33418	11603	4110	7424	1481	507	180
55	replant	0	0	0	0	-6487	-1272	-442	-157	0	0	0	0
56	weed/b.up	0	0	0	0	-1440	-275	-84	-33	0	0	0	0
57	weed/b.up	0	0	0	0	-1120	-208	-68	-24	0	0	0	0
60	f.t Extract	0	0	0	0	0	0	0	0	-2182	-357	-113	-38
60	fell	0	0	0	0	0	0	0	0	-918	-158	-48	-18
60	pulp rev	0	0	0	0	0	0	0	0	-1440	-244	-77	-25
60	saw rev	0	0	0	0	0	0	0	0	7424	1280	397	128
65	f.t Extract	0	0	0	0	0	0	0	0	-18029	-2840	-758	-222
65	fell	0	0	0	0	0	0	0	0	-8318	-1218	-349	-102
65	pulp rev	0	0	0	0	0	0	0	0	8840	1441	413	121
65	saw rev	0	0	0	0	0	0	0	0	128528	18818	5391	1581
65	replant	0	0	0	0	0	0	0	0	-6487	-847	-271	-80
68	weed/b.up	0	0	0	0	0	0	0	0	-1440	-205	-58	-17
70	f.t Extract	-5450	-868	-179	-48	0	0	0	0	0	0	0	0
70	fell	-7871	-888	-257	-88	0	0	0	0	0	0	0	0
70	pulp rev	15120	1810	487	123	0	0	0	0	0	0	0	0
70	saw rev	3248	410	197	28	0	0	0	0	0	0	0	0
75	f.t Extract	-5388	-588	-139	-34	0	0	0	0	0	0	0	0
75	fell	-4018	-438	-103	-25	0	0	0	0	0	0	0	0
75	pulp rev	8800	1048	247	80	0	0	0	0	0	0	0	0
75	saw rev	13820	1517	358	87	0	0	0	0	0	0	0	0
80	net	20408	1818	412	91	1545	145	31	7	0	0	0	0
85	net	23748	1825	375	78	4845	377	73	15	0	0	0	0
90	net	24824	1727	358	58	8184	571	181	19	0	0	0	0
95	net	24073	1452	234	78	10810	852	105	17	1310	78	10	0
100	net	220281	11481	1875	254	11876	808	89	13	1829	95	14	2
101	weed/b.up	-1440	-73	-10	-2	0	0	0	0	0	0	0	0
102	weed/b.up	-1120	-55	-8	-1	0	0	0	0	0	0	0	0
103	weed/b.up	-800	-48	-8	-1	0	0	0	0	0	0	0	0
104	weed/b.up	-800	-37	-5	-1	0	0	0	0	0	0	0	0
105	net	0	0	0	0	12548	583	75	10	3085	138	18	3
110	net	0	0	0	0	143181	5644	889	84	4520	175	21	3
111	weed/b.up	0	0	0	0	-1440	-54	-8	-3	0	0	0	0
112	weed/b.up	0	0	0	0	-1120	-41	-5	-1	0	0	0	0
115	net	0	0	0	0	0	0	0	0	5807	184	21	2
120	net	5997	147	16	2	0	0	0	0	8039	174	17	2
125	net	14104	351	32	3	0	0	0	0	5844	145	13	1
130	net	20408	437	38	3	0	0	0	0	10558	2283	188	18
131	weed	0	0	0	0	0	0	0	0	-1440	-30	-2	0
135	net	23748	438	33	3	1545	28	2	0	0	0	0	0
140	net	24824	388	27	2	4845	74	5	0	0	0	0	0
145	net	24073	331	20	1	8184	112	7	0	0	0	0	0
150	net	220281	2814	148	9	10810	128	7	0	0	0	0	0
151	weed/b.up	-1440	-17	-1	-1	0	0	0	0	0	0	0	0
152	weed/b.up	-1120	-13	-1	-1	0	0	0	0	0	0	0	0
153	weed/b.up	-800	-10	-1	-1	0	0	0	0	0	0	0	0
154	weed/b.up	-800	-8	0	0	0	0	0	0	0	0	0	0
155	net	0	0	0	0	1878	122	8	0	0	0	0	0
160	net	0	0	0	0	12548	111	5	0	1310	12	1	0
165	net	0	0	0	0	143181	1091	48	2	1829	14	1	0
168	weed	0	0	0	0	-1440	-11	0	0	0	0	0	0
167	weed	0	0	0	0	-1120	-8	0	0	0	0	0	0
170	net	5997	23	1	0	0	0	0	0	3085	23	1	0
175	net	14104	80	3	0	0	0	0	0	4520	28	1	0
180	net	20408	100	2	0	0	0	0	0	5807	28	1	0
185	net	23748	243	12	1	0	0	0	0	8039	62	3	0
190	net	24824	90	2	0	1545	8	0	0	5844	21	1	0
195	net	24073	78	2	0	4845	15	0	0	10558	331	8	0
198	weed	0	0	0	0	0	0	0	0	0	0	0	0
200	net	220281	588	13	0	8184	22	0	0	0	0	0	0
201	weed/b.up	-1440	-4	0	0	0	0	0	0	0	0	0	0
202	weed/b.up	-1120	-3	0	0	0	0	0	0	0	0	0	0
203	weed/b.up	-800	-2	0	0	0	0	0	0	0	0	0	0
204	weed/b.up	-800	-2	0	0	0	0	0	0	0	0	0	0
205	net	0	0	0	0	10810	25	0	0	0	0	0	0
210	net	0	0	0	0	11876	24	0	0	0	0	0	0
215	net	0	0	0	0	12548	22	0	0	0	0	0	0
220	net	5997	8	0	0	143181	215	3	0	0	0	0	0
221	weed/b.up	0	0	0	0	-1440	-2	0	0	0	0	0	0
222	weed/b.up	0	0	0	0	-1120	-2	0	0	0	0	0	0
225	net	14104	18	0	0	0	0	0	0	1310	2	0	0
230	net	20408	23	0	0	0	0						

5.4 THE RELATIVE PROFITABILITY OF EVEN-AGED AND UNEVEN-AGED MANAGEMENT

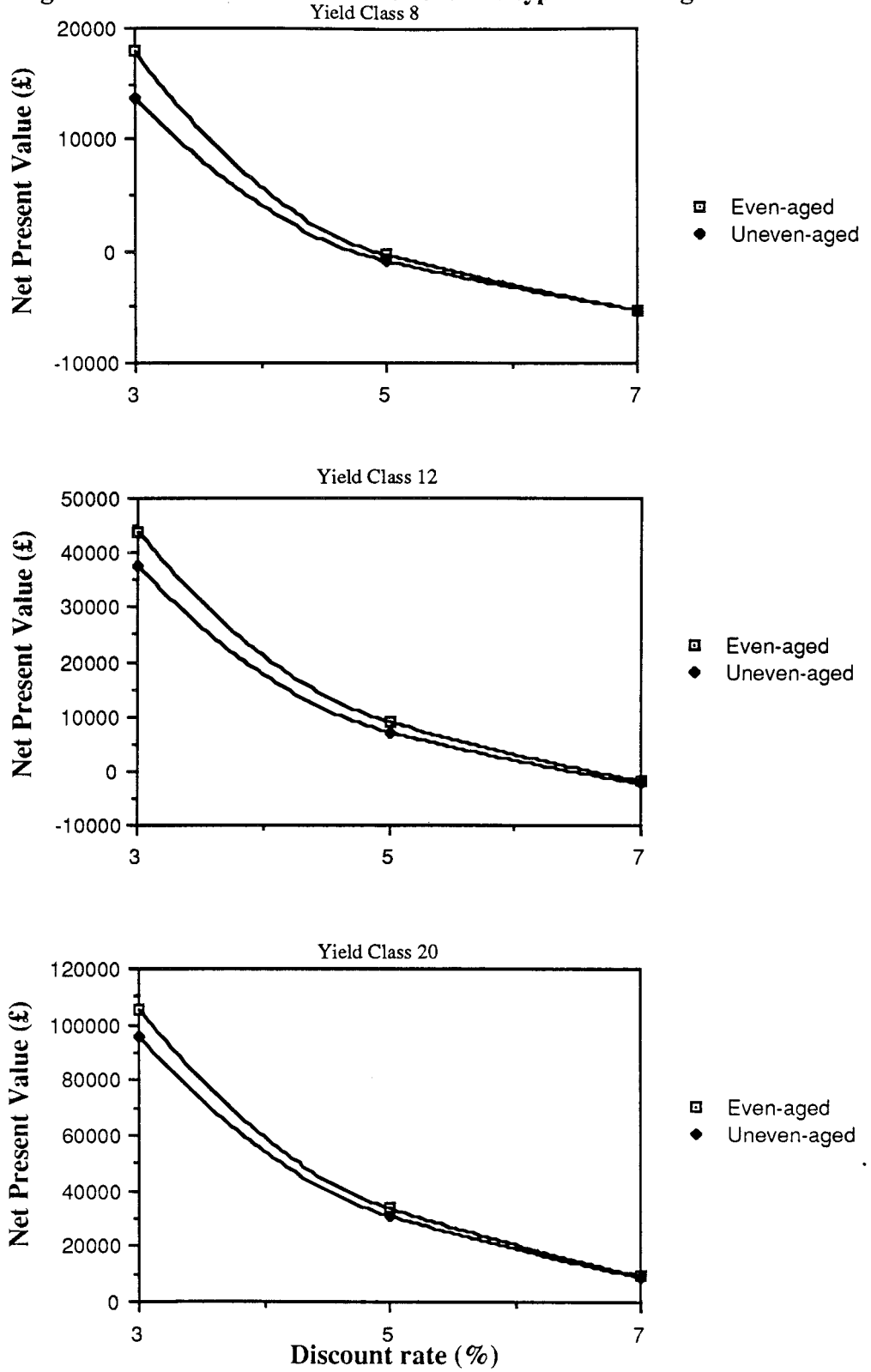
For the uneven-aged management option, the Net Present Value (obtained using the optimum starting age found in the previous section (5.3)) was compared with the values generated from clearfelling a 16 hectare even-aged block at peak MAI. The clearfelling figures were generated by repeating the clearfelling rotation until the present values in each felling period were contributing very little to the Net Present Value, and the values for the uneven-aged option were then projected into the future by the same length of time (250 years in total). The output from the clearfelling calculations is shown in the spreadsheet in Table 5.5 above.

Table 5.6 summarizes the Net Present Values for the two systems, using the same range of discount rates as in the previous section and the results are shown graphically in Figure 5.7.

Table 5.6: Net Present values (E) for even-aged and uneven-aged Management

	Even-aged			Uneven-aged		
	3%	5%	7%	3%	5%	7%
YC 8	17985	-344	-5291	13810	-886	-5268
YC 12	43979	8942	-1841	37588	7109	-2287
YC 20	105776	33696	9459	95809	31006	8863

Figure 5.7: Net Present Values for the two types of Management



The difference in Net Present Value between the uneven-aged option and the even-aged option ranges from -£22 (Yield Class 8 discounted @ 7%) to £10000 (Yield Class 20 discounted @ 3%). The lowest discount rate produces the greatest difference between the two systems for all three Yield Classes and the highest discount rate gives the smallest difference. With a high interest rate the costs and revenues in the early stage of the investment make the greatest contribution to Net Present Value. For the first fifty or so years (depending on the Yield Class) before clearfelling, the net cash flows from each system are similar, with the uneven-aged system giving slightly higher net cash flows. The revenue from the clearfelling of the even-aged block is then so heavily discounted that it contributes relatively little to the Net Present Value. Conversely, with a low discount rate, the final clearfelling revenue at age 50, 55 or 65 makes up a large proportion of Net Present Value and the even-aged system performs better.

5.5 THE EFFECT OF VARYING THE GROUP SIZE

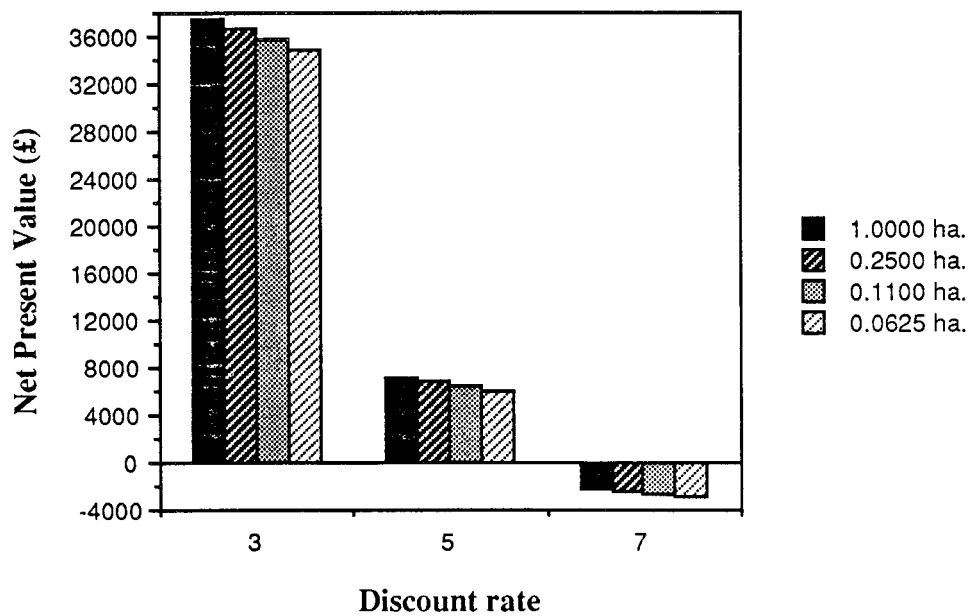
In Table 5.7 the values for the range of group sizes in the baseline example (Sitka spruce, Yield Class 12, 16 ha. block, 40-year transformation) are presented, with the corresponding values for even-aged management of the same block size.

Table 5.7 Net Present Values (£/16 ha block) for even-aged management and a range of group sizes for uneven-aged management

	3%	5%	7%
Even-aged	43989	8944	-1841
1.0000 ha.	37588	7109	-2287
0.2500 ha.	36776	6826	-2435
0.1100 ha.	35885	6452	-2588
0.0625 ha.	34844	6020	-2794

The greatest financial penalty is incurred with the adoption of an uneven-aged management system i.e. the greatest reduction in Net Present Value occurs between even-aged management and the largest group size of the uneven-aged management option. Once the decision to use uneven-aged management has been made, decreasing the group size has less of an impact, but there is a more or less steady decrease in profitability as group size decreases. This rate of decrease in Net Present Value is slightly higher when the group size becomes very small (this occurs with the 0.0625 hectare group in the above example). The results for the four group sizes in the baseline example are summarized in Figure 5.8 below.

Figure 5.8: Net Present Values for a range of group sizes



The results presented here are for the 40-year transformation period, but the discussion in section 5.3 indicated that the longer transformation period (80-years) was a better investment. A longer transformation period would, therefore, reduce the difference between the even-aged and uneven-aged results, although the relative differences between the four group sizes would remain.

The differences in Net Present Value reflect the increased operational costs of working in a fragmented forest block, the increased costs of working in small groups and the reduction in revenue attributable to the area occupied by permanent extraction racks, but they do not include any increased management costs.

The classification of the permanent extraction racks as unproductive land is probably too harsh (in the model, no account has been taken of the probable increase in volume of trees along the extraction racks). Therefore, the differences between group sizes and the two management systems shown above are likely to represent the worst case scenario.

5.6 THE IMPACT OF PLANTING GRANTS ON THE FINANCIAL ANALYSES

The planting grants I have considered are those available under the Forestry Commission Woodland Grant Scheme which was introduced in April 1988. The planting grant rates per hectare vary, depending on the total area planted, according to the table below (Table 5.8). The grant is paid in three installments: 70% on completion of planting, a further 20% after five years and the final 10% after ten years, which is the scheme followed for the spreadsheets when calculating new Net Present Values.

Table 5.8: Rates of Grant for the Forestry Commission Woodland Grant Scheme

Area approved for Planting (ha.)	CONIFERS (£/ha.)
0.25 - 0.9	1,005
1.0 - 2.9	880
3.0 - 9.9	795
10 and over	615

The grant band is determined by the total area planted and "the size of the individual areas within the application will not affect the grant band" (Forestry Commission, 1988). This means that regenerating a forest by means of very small groups does not necessarily qualify for the highest grant band. However, in most cases of uneven-aged forestry the length of the transformation period dictates that the total area regenerated in

any one period is also small and is likely to qualify for one of the higher grant bands, if not the highest.

For the 16 hectare block used as an example up to this point, the rate of grant for the even-aged version of the block is £615 per hectare, because the 16 hectare block falls into the lowest grant band (10 hectares or more), whereas the grant for the uneven-aged version is £880 per hectare because only 2 hectares of the 16 hectare block are regenerated during any single felling period. This difference in planting grants serves to narrow the gap in Net Present Values between the two systems as shown below in Table 5.9 and Figure 5.9 which correspond to Table 5.6 and Figure 5.7 for the situation where planting grants are not included.

Table 5.9: Net Present values (£) for even-aged and uneven-aged Management (with Planting Grants)

	Even-aged			Uneven-aged		
	3%	5%	7%	3%	5%	7%
YC 8	29105	9097	3611	26205	9100	3906
YC 12	55586	18640	7169	50409	17439	7027
YC 20	117840	43593	18559	110363	41767	18501

The planting grants are paid on a per hectare basis, irrespective of the Yield Class of the planting site which is why the Net Present Values for the Yield Class 8 site are most altered by the inclusion of planting grants. Revenues from the planting grants make up a large proportion of total revenue on such a poor site.

The inclusion of planting grants brings forward slightly the optimum age to begin the transformation from an even-aged to uneven-aged structure, because the grants make the early unprofitable fellings slightly more profitable. Also, the discount rate at which the two systems have the same Net Present Value is lower due to the higher rates and earlier receipts from planting grants with the uneven-aged system.

Figure 5.9: NPV's (with Planting Grants) for the Two Systems

