Appendix B
Sensitivity Analysis

This appendix describes the sensitivity of our estimates of the social return on public investment, the social return on investment, and the private return on investment to changes in key parameters.

B.1 SENSITIVITY OF SOCIAL RETURNS

We examined the sensitivity of the social return on public investment and the social return on investment to the following parameters:

- discount rate,
- per-patient treatment costs and QALYs, and
- probability of technical success.

B.1.1 Sensitivity to the Discount Rate

Changing the discount rate has a complex effect on the social NPV. First, if the technology has a QALY impact, it affects the total number of QALYs gained per patient, since QALYs that occur later in life are discounted. Second, it affects the value of a QALY, as explained in Section 2. Finally, it affects the rate at which the expected net benefits are discounted.

Table B-1 shows the value of the social NPV when the discount rate is 5 percent and 1 percent. The composite social returns on all projects are about 40 percent lower than baseline at a 5 percent discount rate and about 75 percent higher than baseline at a 1 percent discount rate. For most projects, decreasing the discount rate increases the NPV of social returns. For one project, "Proliferated Human Islets," the social benefits are negative at a 5 percent discount rate because at this rate the discounted value of the lifetime health-related benefits per patient is less than the discounted lifetime cost of treatment. Because the per-patient net benefits are negative for this project, the impact of ATP on the return on investment from this project is also negative, because the with-ATP scenario includes more patients. The increase in the discount rate decreases the value of improvements in the quality of life, which occur late in life relative to the cost of treatment.

Table B-1. Social Return on Investment and Social Return on Public Investment: ATP Projects in Tissue Engineering for a Single Application: 5 and 1 Percent Discount Rates (NPV 1996$ millions)

ATP Project	5 Percent		1 Percent	
	Expected Social Return on Investment	Expected Social Return on Public Investment	Expected Social Return on Investment	Expected Social Return on Public Investment
Stem Cell Expansion	$94	$33	$190	$65
Biopolymers for Tissue Repair	$77	$77	$125	$125
Living Implantable Microreactors	$39,930	$10,461	$138,866	$29,634
Proliferated Human Islets	($924)	($313)	$8,165	$4,029
Biomaterials for Clinical Prosthesis	$24,339	$11,493	$45,092	$20,041
Gene Therapy Applications	$449	$990	$2,278	$866
Universal Donor Organs	$3,568	$1,001	$1,866	$504
Composite	$63,961	$21,992	$193,036	$54,321

B.1.2 Sensitivity to Estimates of Health Benefits

Social returns are relatively insensitive to changes in per-patient treatment cost and QALYs, except for one project.

The health benefits models estimate the benefits of ATP-funded technologies in tissue engineering by calculating the change in the cost of treating patients and the change in the benefits to patients in terms of QALYs. Table B-2 demonstrates the sensitivity of the results with respect to the change in the cost of treatment and the QALYs gained by using the new technology. The table shows the percentage change in each project's social NPV when the per-patient cost or the per-patient change in QALYs is varied by 25 percent. With the exception of "Proliferated Human Islets," none of the results are overly sensitive to our data regarding these benefits and costs. However, the results for this project are very sensitive to both of these estimates partly because the percentage changes are calculated on a small base. If the company revises its estimates of the cost of the diabetes treatment, or if we can develop more accurate estimates of the QALYs gained by this treatment, the social returns from this project may be substantially larger or smaller.

Table B-2. Sensitivity of Social NPV to a 25 Percent Change in Per-Patient Treatment Cost and QALYs

ATP Project	Percentage Change in Expected Social Return on Investment (NPV)	
	Cost	QALYs
Stem Cell Expansion	25%	N/A
Biopolymers for Tissue Repair	25%	N/A
Living Implantable Microreactors	11%	36%
Proliferated Human Islets	362%	381%
Biomaterials for Clinical Prosthesis	N/A	25%
Gene Therapy Applications	1%	26%
Universal Donor Organs	7%	18%

NA = not applicable

B.1.3 Sensitivity to the Probability of Technical Success

Table B-3 shows how the results of our analysis change if we assume that the probability of technical success is equal to 1. Note that in our model, the expected benefits and costs *following the R&D phase* are multiplied by the probability of technical success. The table shows how our estimates of the social return on public investment, NPV, and IRR would be different if there was no uncertainty about the technical success of these projects. Although the NPV is significantly higher in some cases, the IRR does not change a great deal because both costs and benefits in the commercialization and production phases are multiplied by the probability of technical success.

B.2 SENSITIVITY OF PRIVATE RETURNS

This section describes the sensitivity of private returns to several key parameters:

- discount rate,
- commercialization cost percentage,
- production cost percentage,
- product price, and
- probability of technical success.

Table B-3. Sensitivity of Expected Social Return on Investment to Probability of Technical Success

Project	NPV (millions)		IRR	
	Under Baseline Assumption	When Prob of Success = 1	Under Baseline Assumption	When Prob of Success = 1
Stem Cell Expansion	$134	$168	20%	21%
Biopolymers for Tissue Repair	$98	$131	51%	55.36%
Living Implantable Microreactors	$74,518	$78,441	149%	149%
Proliferated Human Islets	$2,252	$6,787	36%	37%
Biomaterials for Clinical Prosthesis	$32,855	$41,070	118%	121%
Gene Therapy Applications	$2,411	$6,971	106%	129%
Universal Donor Organs	$2,838	$6,310	91%	101%

For the discount rate, we calculated the value of composite NPV for 5 percent and 1 percent discount rates. For the probability of technical success, we compared the value of composite NPV under the baseline assumptions to the NPV when the probability of success is 1. For the other variables, we varied them from their baseline values by 25 percent and calculated the percentage change in composite NPV.

B.2.1 Sensitivity of Results With Respect to the Discount Rate

As shown in Table B-4, our estimates of private return on investment are fairly sensitive to the discount rate assumption. Increasing the discount rate from 3 percent to 5 percent changes composite private returns by about 38 percent from the baseline result. Decreasing the discount rate from 3 percent to 1 percent increases composite NPV by about 54 percent.

Table B-4. Private NPV for ATP Projects in Tissue Engineering for a Single Preliminary Application: 5 and 1 Percent Discount Rates (1996$ millions)

	5 Percent	1 Percent
Project returns	$977	$2,409
Increment attributable to ATP	$589	$1,369

B.2.2 Sensitivity of Results with Respect to Cost Parameters

As explained in Section 2, we had very little data on costs that companies would incur during commercialization and production. In the absence of information from the companies, we developed assumptions for these variables based on average values in the pharmaceutical and biotechnology industries. We assumed that the

- commercialization cost is 37 percent of expected revenue and
- variable cost of production is 42 percent of revenue.

Composite private return on investment is most sensitive to changes in assumptions about the commercialization cost and the cost of production.

We also made various assumptions about product price, based on our interviews with company representatives. Table B-5 shows the percentage change in composite NPV given a 25 percent change in these parameters. The sensitivity of the NPV estimates varies widely across projects. For some projects, the NPV is very sensitive to these assumptions. The composite returns are most sensitive to changes in our assumptions about production cost and commercialization cost. Thus, our confidence about our estimates of private returns depends largely on our certainty about these assumptions. Given that we used secondary industry information, we believe these estimates can be improved in the future by updating them with data from the companies when it is available.

Table B-5. Sensitivity of Results with Respect to Key Parameters

Parameter	Percentage Change in Composite NPV
Commercialization cost	67%
Production cost	72%
Product price	28%

B.2.3 Sensitivity to the Probability of Technical Success

Table B-6 shows how the composite private return on investment changes if we assume that the probability of technical success is equal to 1. The table shows how our estimates of the composite NPV and IRR would be different if there was no uncertainty about the technical success of these projects. The composite NPV is about 66 percent higher when we assume that all projects are successful. However, the IRR does not change because the costs of commercialization and production are higher, as are the benefits, when we are certain of success.

Table B-6. Sensitivity of Composite Private Return on Investment to Probability of Technical Success

	NPV of ATP Project (thousands)	IRR of ATP Project
Under baseline assumptions	$1,564	12%
When probability of success = 1	$2,605	12%