Table 4-7 Representative Pricing of Conventional Color TV Receivers

Typical Price of Conventional NTSC Tube TV Sets by Screen Size		
Brand	**Screen Size**	**Price**
Samsung TXK2567	25"	$ 269.99
Samsung TXK2767	27"	$ 299.99
Samsung TXK2768	27"	$ 349.99
Panasonic CT27D21	27"	$ 369.99
SONY KV27S42	27"	$ 399.99
Toshiba 27A60	27"	$ 429.99
SONY KV27V42	27"	$ 449.99
Panasonic CT27SX10	27"	$ 599.99
Sony KV27FS12	27"	$ 599.99
Samsung TXK3279X	32"	$ 599.99
Panasonic CT32D31	32"	$ 649.99
SONY KV32S42	32"	$ 699.99
Toshiba 32AX60	32"	$ 699.99
Samsung TXK3679X	36"	$ 849.99
Toshiba 36AX61	36"	$ 999.99

4.1.7 Typical Retail Markups for Television Receivers

Since the data applied in this study include a mixture of retail prices (e.g. TV receiver prices) and component costs (e.g. video integrated circuit prices), it is necessary to understand the relationship between manufacturing costs and the manufacturer prices. To gain insight on this topic, interviews were conducted with a number of knowledgeable manufacturer and industry representatives. In particular, interviews were conducted with representatives of the following organizations:

- RCA/Thomson;
- Zenith/LG Semiconductor;
- Philips/Magnavox; and
- Consumer Electronics Association.

These interviews provided a consensus viewpoint that profit margins (i.e. manufacturer's price relative to manufacturing cost) for a low-end or "leader" model television receiver is in the range of 1.5 to 2.0 times the manufacturing cost. For high-end receivers, higher markups in the range of 2.0 to 2.5 times manufacturing costs may be applied.

Discussion with a leading Boston area retailer (Tweeter, Etc.) revealed that retail markups (i.e. retail price relative to manufacturer's price) are generally about 20% for "leader" models and 35% for higher end sets.

4.1.8 Interview Program

Following research of public information and the development of initial model-based forecasts, we engaged in a program of interviews with knowledgeable 3rd parties to validate our findings and refine our assumptions and models. Interviewees fall into three categories:

- Consumer electronics (CE) manufacturers and manufacturing representatives;
- Integrated circuit supplier of ATSC/DTV chip sets; and
- Consumer electronics retailers.

CE Manufacturers

Prior to meeting with each stakeholder, we prepared a discussion package which documented our project objectives and initial findings. The package was organized into the following topic areas:

- Objectives of project and the interview
- Overview of project approach and schedule
- Discussion of a reference architecture for a DTV receiver as a basis for a cost model
- Review market demand data
- Review and discuss the current situation for pricing and costs
- Discussion of the initial ADL analysis and underlying assumptions
- Identification and discussion of key issues which might drive costs and timing including:
  - Demand assumptions for shipments and cost sensitivities
  - Cost elements including present and future DTV architectures and trends in key component costs
  - Learning curve theory and assumptions including today's costs, today's volumes, and appropriate learning curve percentage factors
  - Special topics including set-top transverter costs and delta costs for high end versus leader model sets.

Representatives from the following CE manufacturers and manufacturing representatives were interviewed:

- Consumer Electronics Association
- Philips (Magnavox)
- Thomson (RCA)
- Zenith/LG

In all cases the parties interviewed were senior engineering staff directly associated with DTV product R&D and product definition.

The interviews confirmed our modeling methods, general approach, and assumptions but did provide for a significant adjustment in the starting point (i.e. today's incremental costs to enable DTV). In particular the key points of consensus were:

- The starting incremental cost to add a DTV receiver should be in the range of $100 and not the $200 or more range suggested by some in responses to the FCC. It was suggested that these higher costs might be appropriate for an HDTV receiver implemented in technology available 1-2 generations ago but that using the reference designs from current IC providers would allow a 480I SDTV implementation at about $100 incremental material costs. Note that a HDTV receiver would involve additional costs above 480I SDTV for memory, higher speed logic, etc; beyond the additional costs for high resolution display, deflection components, and power supply.

- A manufacturer markup of 1.5X times material cost is typical for a "leader" model set while a factor of 2.0X is typical for a high end receiver.

IC Manufacturer

We researched public information on a number of IC suppliers as further indicated in this report but interviewed only STMicroelectronics (ST) as they had the most recent announcement of next generation DTV chip sets. In particular their Sti7020 was announced July 2, 2001 [STMicroelectronics, 2001][2]. This device provides nearly all the signal processing required to receive ATSC in a single chip.

ST described their reference design for a "leader" model DTV receiver and confirmed that they support the $100 incremental cost stated by CE manufacturing representatives. In particular, they described their reference design which includes: STi7020 decoder, DTV tuner, VSB decoder, NTSC decoder, multiplexer, memory, and miscellaneous components; with a total cost of about $101 (including $35 for STi7020)[3].

Motorola MCT5100 M-DTV is intended to provide an "add-in" DTV reception capability for existing analog TV set chassis designs. Based on a press release in November 2000, it would be available in the first quarter of 2001 and priced at $150 in quantities of 100,000.

Consumer Electronics Retailers

We have also collected information from Circuit City and Tweeter Etc. There were a variety of topics covered:

- Current consumer awareness and interest in DTV receivers and set-top boxes
- Current pricing for analog NTSC and DTV-ready low and high end receivers
- Retailer perspectives on consumer price sensitivity and indifference to extra costs for DTV
- Typical retail markup between factory price and retail price

Again we found a strong consensus between the two retailers as well as confirmation on assumptions.

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[2] See Electronic Engineering Times, July 2, 2001, page 83.
[3] Telephone interview with STM.

The key findings were as follows:

- When a new feature is first introduced, there is an acceptable incremental price consumers would pay for the new feature, for example, the addition of a 'remote control' which initially might add $50 to the sale price of a typical TV. Based on the opinion of the retail store manager that we interviewed, the consumer will pay about an additional $60 for a DTV receiver in their new TV. This $60 is a considered a level of indifference. There is a belief that even if the consumers could not receive DTV today, they would pay that premium to assure against early obsolescence of their new receiver.

- For leader low-end sets, (versus the most expensive typical TV, or the more expensive high-end TV), the point of indifference is lower than $60, typically, about 20% of the retail cost. That is, the consumer will tolerate a $30 premium on a $150 set to include a digital receiver.

- Some quotes from our interview were as follows:

  - "When 27 inch HDTV sets are available, that will be the set to buy - the threshold for mass market." [i.e., the market will takeoff. This is based on the size of the average living room and the ratio of screen height to viewing distance]. (from a retail store manager)
  - "People shop for a set based on a specific screen size." (from a retail store manager)
  - "In general, the lower the price of a set, the lower the margin to all parties" (manufacturer and retailer).
  - Retailer price is $169 for a 21" Samsung, which includes 19% markup. "The markup on video equipment is lower than that of other consumer electronics equipment, so sales people are encouraged to sell add-ons" (e.g., home theater). (from a retail store manager)
  - "For a high-end receiver, a more typical markup would be 35%." (from a retail manager)

4.2 Key Assumptions

The data and information described in Section 4.1 are used to derive a number of key assumptions to be applied in the analysis of the cost of widespread enabling of DTV capabilities.

Specifically, the following key observations have been made, based on discussions with industry representatives and review of secondary research on DTV and related markets:

- Adoption occurs in accordance with the Bass Adoption Theory with parameters p (coefficient of innovation) and q (coefficient of imitation) similar to those associated with the adoption of color TV technology;

- The analysis is limited to television receivers with 13 inches or larger screens;

- Based on the CEA data[CEA, 2001b], the annual television sales in the U.S. for year 2000 are about 25 million units;

- The initial incremental material cost (as of 2001) to enable DTV reception on a "leader" model NSTC TV is approximately $100 (we note that this figure of $100 is about one-half to one-third of the figure expressed by Thomson in their FCC filing [FCC, 2001b], and we support this lower figure based on the research and interview findings in Appendix B);

- Due to limitations in available data, it was necessary to approximate the penetration of DTV technology as the ratio of sales to TV households. This approximation assumes that, over the study period, each sale represents a newly adopting household and that no household retires digital service;

- The US TV households 2001 – 2008 are based on Carmel Group's forecast [Carmel Group, 2001a]. The subsequent years' estimates (2009-2015) were forecasted based on the average growth rate of Carmel Group's previous 8 years forecast numbers.

- The FCC's "must-carry" rule [47 USC, 2000b; FCC, 1993a & 1994], is still being finalized, and there are several possible outcomes with regard to mandated native 8-VSB carriage for broadcast signals on cable. For the purpose of this report, we assume that consumers will want so called "cable ready" TVs, and that parallel to today's situations, they will want these TVs to demodulate both 8-VSB broadcast signals as well as QAM cable signals. Therefore we assume that the minimal implementation of a SDTV leader model set will be "cable ready" and capable of demodulating both 8-VSB and QAM physical layers;

- The cost to incorporate a DTV receiver in a high-end TV receiver is likely to be lower than that for a low-end model since most high-end receivers include digital signal processing components, such as picture-in-picture and comb filtering.

- In estimating the fraction of TV sets with screens greater than or equal to 32 inches, it was necessary to assume that the market share represented by sets 29 inches and above is approximately the same as the share for sets 32 inches or above (i.e. the relative share of 29 inch screens is negligible). This assumption is required since the available data (i.e. Table 4-6) were presented for 29 inch or larger screens while the phased-mandatory scenario initially affects sets of 32 inch or greater screen size.

- The overall growth in TV sales is assumed to be driven by annual US population growth:

  - The growth rate in TV sales is assumed to be driven by the growth rate in US households which, according to U.S. Census data, averaged 1.65% from 1997 to 1999 [US Census Bureau, 2000];
  - The baseline growth rate in TV sales is assumed to be approximately 1.5% [CEA, 2001b], which is generally consistent with the growth in U.S. households. This rate (1.5%) has been assumed as the overall sales growth in TV sales for purposes of this report;
  - For sensitivity analysis, lower (0.75%) and higher (3%) growth rate scenarios are evaluated.

- The manufacturers' markup factors are 1.5 times and 2.5 times respectively to leader model TV receivers and high-end sets. Retail profit margins are 20% and 35% to leader model and high-end sets respectively. We further assume that set-top box (STB) transverters have the same markup factor and profit margin as those of leader model TV receivers because other advanced features may have been included in the high-end STBs which we do not consider in this study.

These observations, along with the secondary data and interview results are applied in Section 5, Cost Analysis.

5 Cost Analysis

5.1 Scope of Analysis

To obtain an overall perspective on the rate of DTV adoption and associated economic impact, several adoption scenarios have been considered in this study. In particular, the following scenarios have been selected for analysis:

- Three scenarios:

  - ***Baseline Scenario:*** Digital TV adoption is driven solely by natural market forces where a consumer's purchase decision is based solely on the benefits of a DTV receiver relative to the additional cost;

  - ***Mandate Scenario:*** Institution of a government mandate requiring inclusion of a DTV receiver in all sets sold [manufactured] subsequent to a specified future date:

    - Institution of a government mandate that all TV sets 13 inches and above sold after January 1, 2004 should have the capability of receiving digital television;
    - January 1, 2004 is assumed the cut-off date based on the FCC's proposed DTV transition rule which states that, by May 1, 2002, all commercial television stations must commence digital service, and all non-commercial television stations must begin [digital transmission] by May 1, 2003 [FCC, 1997; 47 CFR, 2000]. Under these assumptions, by January 1, 2004, most households should have the ability to access digital television content.

  - ***Phased Mandate Scenario:*** Institution of a phased government mandate whereby more sophisticated, high-end receivers will be required to include a DTV receiver, and gradually over time, the requirement will be extended to include lower-end models as well:

    - Effective in 2003, all TV sets manufactured with screen sizes 32 inches and above (approximately 19% of total TV sales) must have the capability of receiving digital television;
    - Effective in 2004, all sets with screen sizes 25 inches and larger (summed approximately 56% of total TV sales); must have the capability of receiving digital television;
    - Effective in 2005, all sets having screen sizes 19 inches or above (summed approximately 85% of total TV sales) must have the capability of receiving digital television; and
    - Effective in 2006, all TV sets must have the capability of receiving digital television;
    - This phased mandate scenario is based on the FCC's proposed approach in its *Report and Order and Further Notice of Proposed Rule Making in the Matter of Review of*

the Commission's Rules and Policies Affecting the Conversion To Digital Television: "One approach to minimize the impact of such a requirement would be to phase it in over time to take advantage of declining costs associated with electronics manufacturing volumes and apply the requirement initially only to receivers with large screen sizes, e.g. 32 inches and above." [FCC, 2001c].

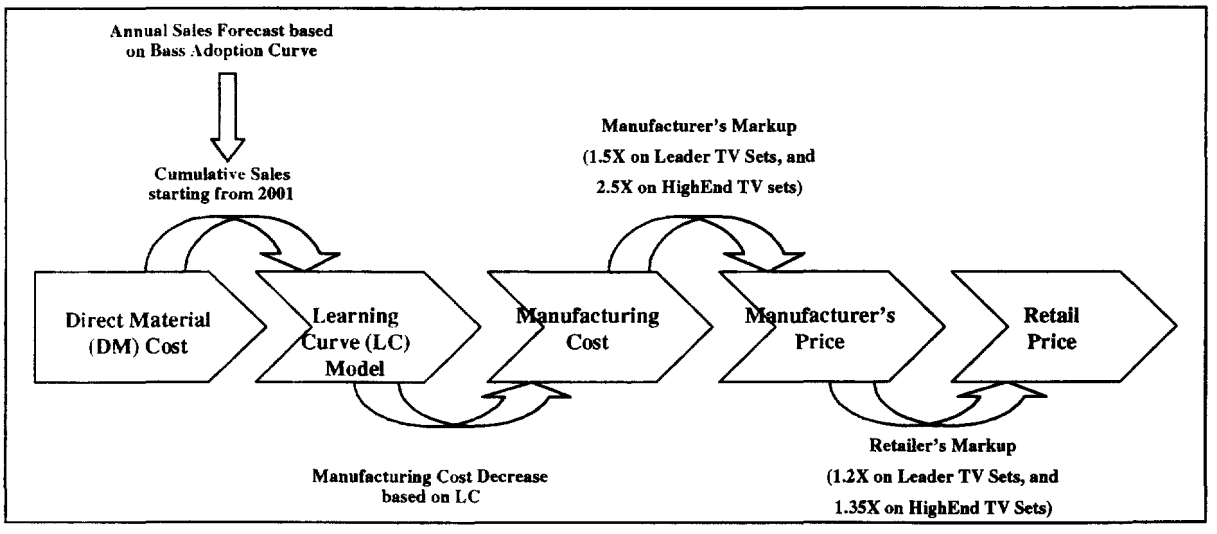
- Sensitivity analysis on the baseline key assumptions to test the robustness of results to changes in the assumptions has been conducted.

The following sections summarize the approach and results obtained.

5.2 Analysis and Methodology

To assess the cost impact related to the inclusion of a DTV receiver, several cost models were developed. These models applied standard mathematical constructs for product penetration and suitable model parameters are estimated from available data and judgement of the project team and industry representatives. In particular, two major components of the model consist of the rate of product adoption and the rates at which component prices are expected to decline as a function of production volume. These effects were modeled using an established theory of product adoption (Bass Theory) and an established model for semiconductor price reduction (Learning Curve Theory) with increases in volume. These central models serve as the basis for the analysis and results presented in this section. The overview of the analysis and methodology are shown in Figure 5-1.

Figure 5-1 Analysis and Methodology Overview



5.2.1 Bass Adoption Theory

The Bass Adoption theory is a mathematical model that is well established and accepted for developing estimates of the expected rate of market adoption of new products and technology. It

is based on the fundamental concepts that market adoption is driven by two primary characteristics of the product or technology:

- Innovation – The extent to which the product represents an innovative technology that is useful to consumers "in isolation" regardless of the number of other users adopting the product. Examples might include PDA technology or video recorders which are useful to an individual user who acquires them whether or not his acquaintances also adopt the device;
- Imitation – The extent to which effective use of the product depends on other users also having the product. This dependence can arise either from the device's intrinsic utility (e.g. two way radios which are useful only if there are other individuals with whom to talk) or from exposure to the product and peer pressure (e.g. electronic devices in "trendy" colors).

The Bass model has been successfully applied to a variety of diverse consumer and industry product adoption processes including:

- Electric Refrigerators;
- Air Conditioners;
- Color Television Sets; and
- Citizen's Band (CB) Radios.

In the Bass theory, differential equations approximating these effects are developed and solved to yield the following adoption expression [Takada, Hirokazu & Jain, 1991]:

$$F(t) = \frac{1 - e^{-(p+q)t}}{1 + \frac{q}{p} e^{-(p+q)t}} \qquad (3.1)$$

Where:

t = Time

$F(t)$=Fraction of adoptors by time t

p = Coefficient of Innovation

q=Coefficient of Imitation

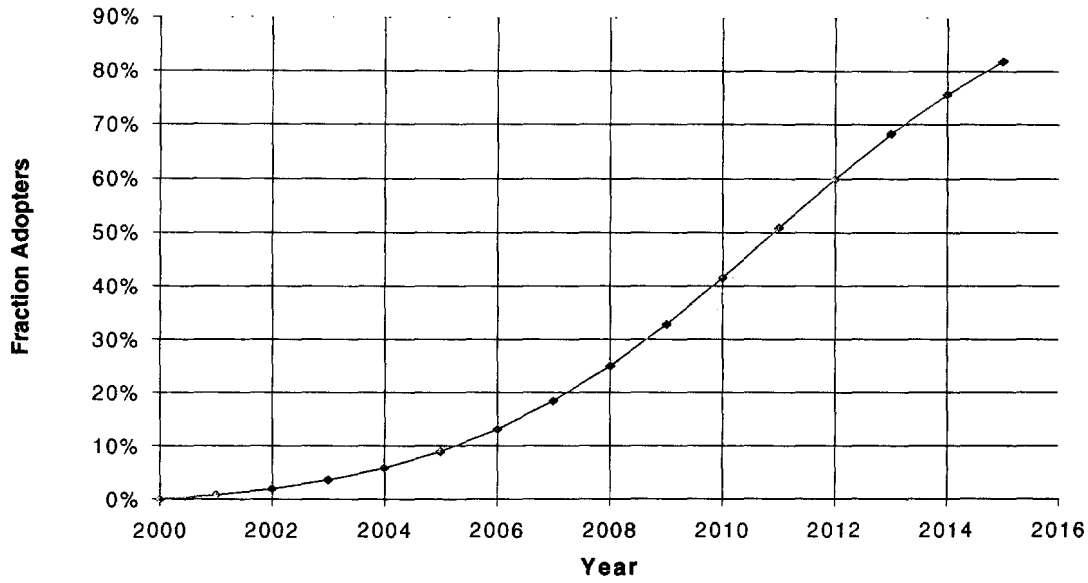
These expressions for product adoption were applied in the mathematical spreadsheet models used in this analysis. For purposes of this analysis, the innovation and imitation coefficients have been assumed to be those associated with the historical adoption of color television. Specifically, it has been assumed that [Helsen, Jedidi and DeSarbo, 1993]:

$p = 0.007$

$q = 0.357$

Under these assumptions, the application of the Bass model produces the DTV adoption curve shown in Figure 5-2.

Figure 5-2 Estimated DTV Adoption Curve



5.2.2 Learning Curve Theory

It is well known that the prices of semiconductor devices generally decline with increases in cumulative production [Gruber, 1994]. From this reference, it is noted that a basic learning hypothesis is applicable to a wide range of industries, especially, technologically complex processes. In particular, it is reported to be applicable to the semiconductor industry. The basic concept is that production efficiency improves with experience and results in reduced labor and cost of production. This paper indicates, for example, using the data reviewed that the learning curve factor (Percent cost resulting from a cumulative doubling of volume) ranged from 0.68 to 0.75 for the semiconductor products reviewed. The paper further concludes that regardless of the type of digital integrated circuit that the learning curve factors tend to average about 0.75 learning factor. Therefore for the purposes of this study, it has been assumed that the price of components will be reduced by a factor of 0.75 (i.e. 25% cost reduction) for each doubling of cumulative production. Under this assumption, the cost reduction may be expressed using the following relation:

$$C_t = C_0 \left[f^{\frac{\ln(V_t/V_0)}{\ln(2)}} \right] \qquad (3.2)$$

Where:

t = time

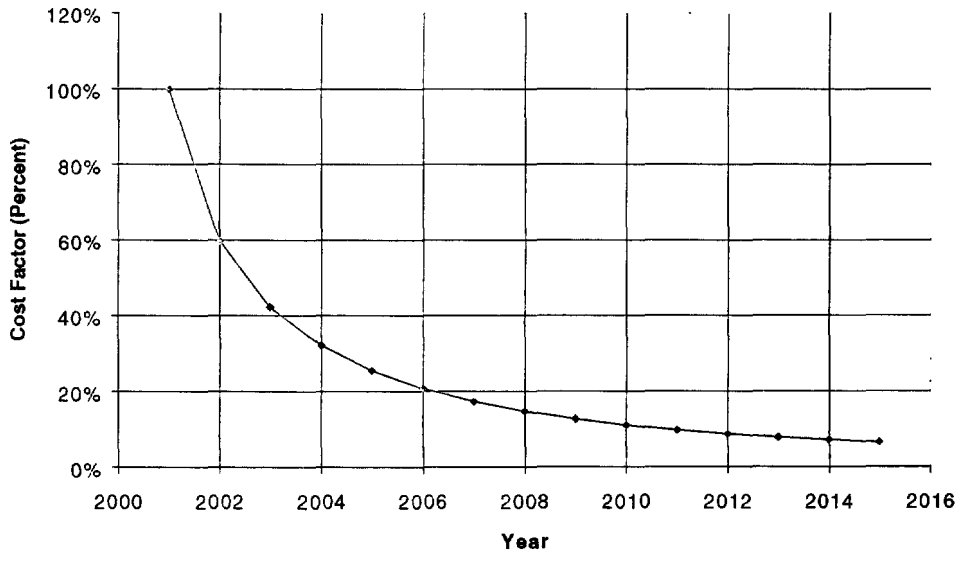
C_t = Cost at time t

V_t = Sales Volume at time t

f = Fraction of original cost resulting from doubling cumulative volume

Applying this model, the manufacturing learning curve in Figure 5-3 is obtained for the Baseline (free market adoption) Scenario. Industry representatives, with whom we discussed these results, were in general agreement with the levels of cost reduction predicted.

Figure 5-3 Estimated Component Cost Learning Curve (Percent - Baseline Scenario)



These curves are assumed in the subsequent analysis.

5.3 Integrated Leader Model DTV

The focus of this study is on integrated digital TV receivers. In this section, the integrated DTV analysis is presented for a leader model (i.e. Case A in Figure 3-1) SDTV for each of the three scenarios.

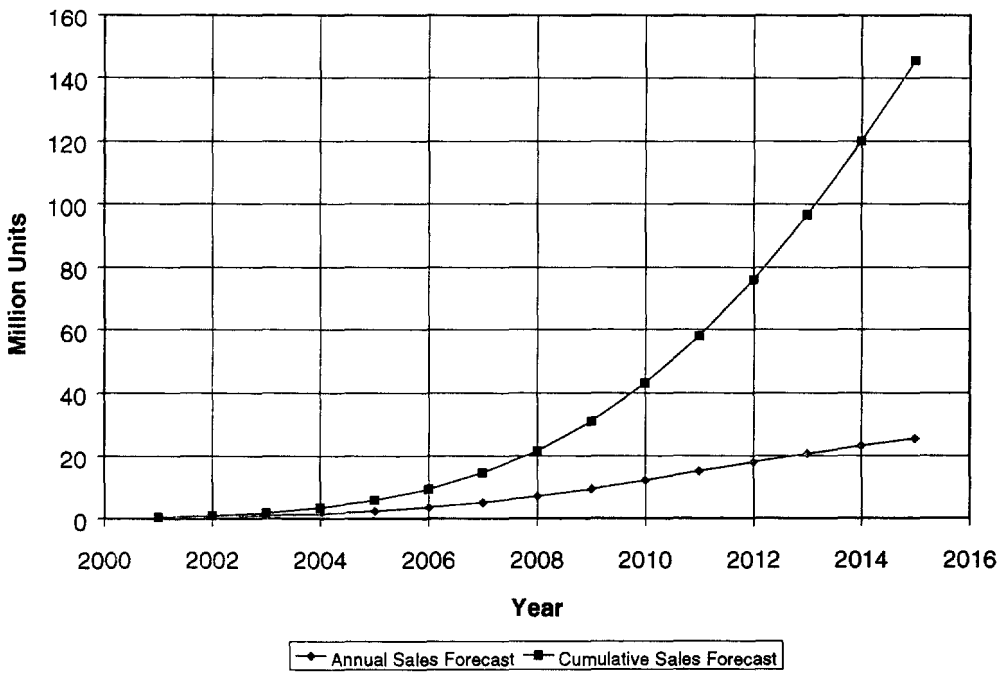
5.3.1 Baseline Scenario: Free Market Adoption

In the baseline scenario, adoption of DTV technology is assumed to be driven solely by market forces without governmental intervention. In this case, the market dynamics are approximated by adoption according to the Bass Theory, and incremental costs begin at $100 per TV set and decline according to the learning curve presented in Section 5.2.2. of this report.

5.3.1.1 Baseline Sales Forecast

Assuming the year 2000 television sales in the U.S. represent 25 million units, we apply a 1.5% annual TV sales growth rate and adopting the assumptions and models presented above leads to the DTV sales forecast presented in Figure 5-4.

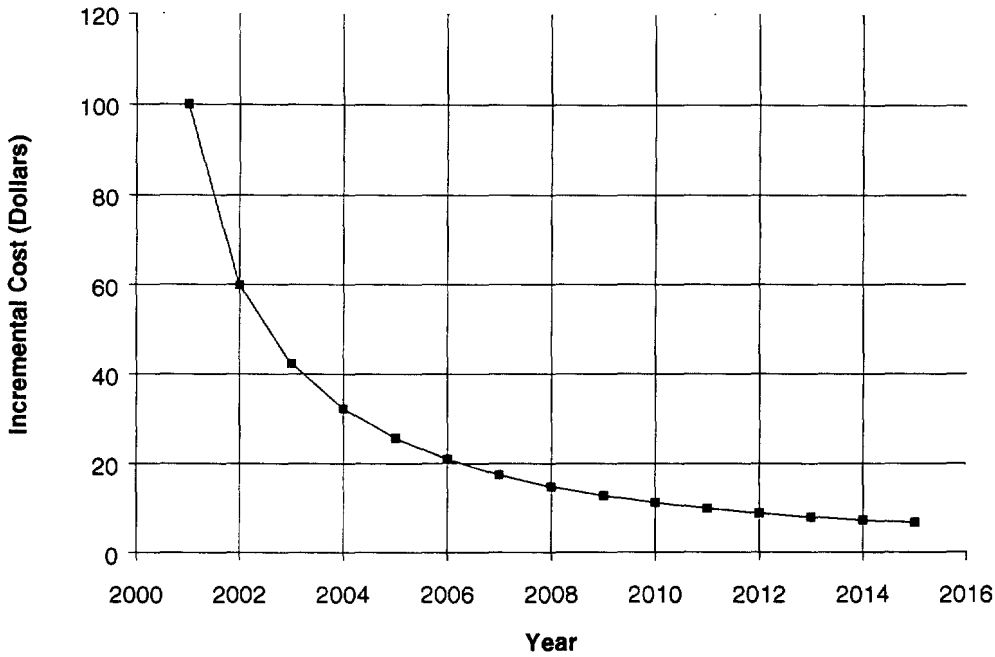
Figure 5-4 Baseline U.S. Sales Forecast for DTV



In this model, the cumulative DTV sales under the free market adoption scenario are predicted to reach almost 9.3 million sets by Year 2006. Assuming the Carmel Group's TV household forecast number 109.3 million in year 2006 [Carmel Group, 2001a], the 2006 DTV penetration would be approximately 8.5%. Under these assumptions, 85% household adoption rate would not be realized probably until 2014.

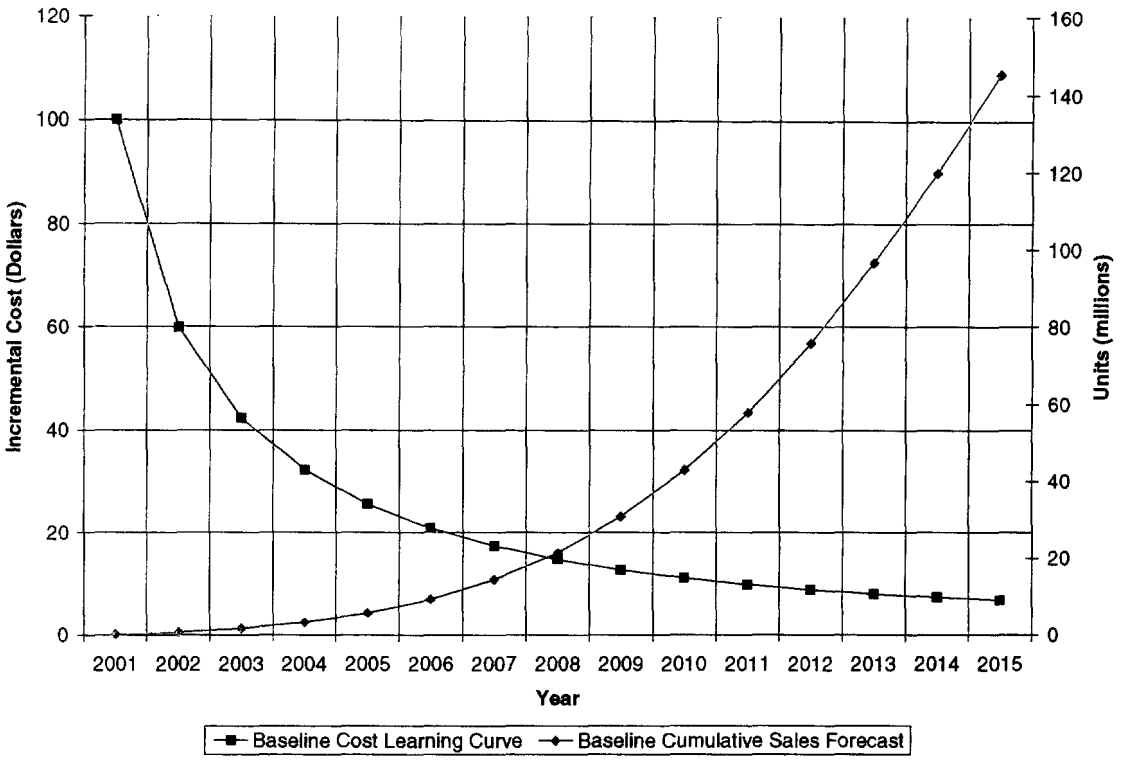
Given the assumed learning curve, the incremental material cost would, under these assumptions, decrease from $100 to approximately $21 by year 2006. See Figure 5-5 below.

Figure 5-5 Assumed Cost Learning Curve for Components (Cost – Baseline Scenario)



The Figure 5-6 illustrates the DTV sales forecast and cost learning curve combined under the baseline case scenario over study period. As shown, the cumulative DTV sales increase from 0.21 million in 2001 to 9.3 million in 2006; while the incremental cost declines from $100 to $21 per set in the same time frame.

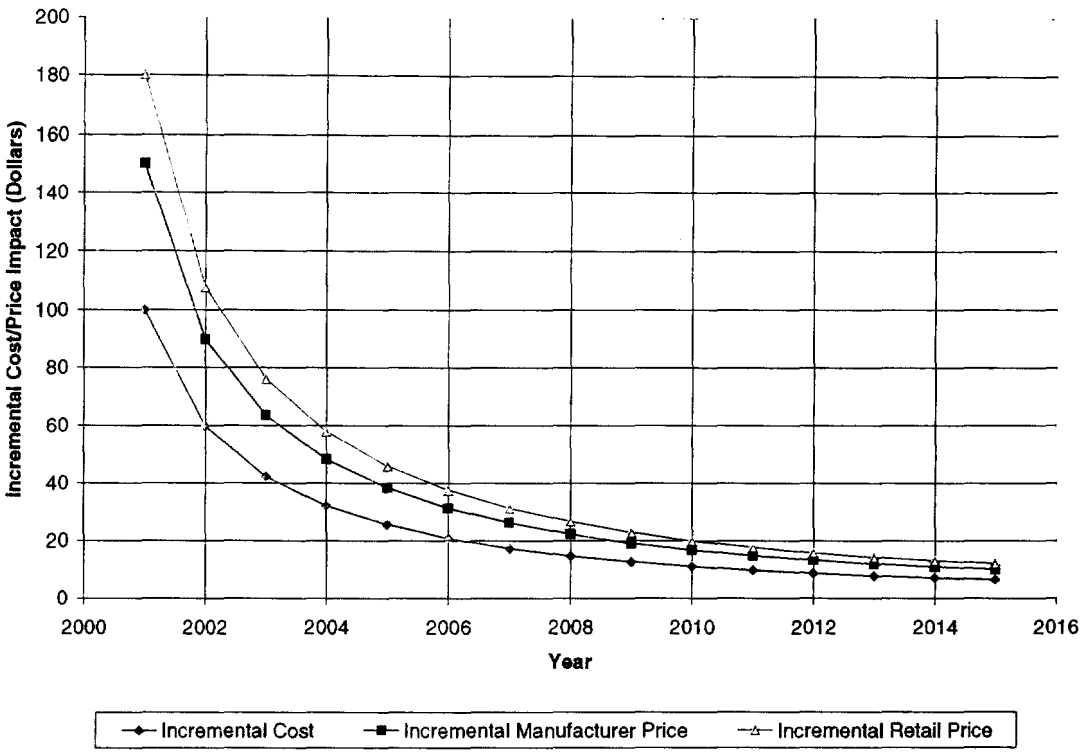
Figure 5-6 Baseline DTV Sales Forecast and Cost Learning Curve



5.3.1.2 Predicted Effect on Manufacturer and Retail Pricing

By applying a 1.5 markup factor to direct material cost and a 1.2 markup for retail margin, the price impact curve in Figure 5-7 is derived.

Figure 5-7 Estimated Impact on Manufacturer and Retail Price



Based on the assumed markups and models, the incremental retail price associated with inclusion of a DTV receiver would initially be $180 and would decline to approximately $38 by year 2006.

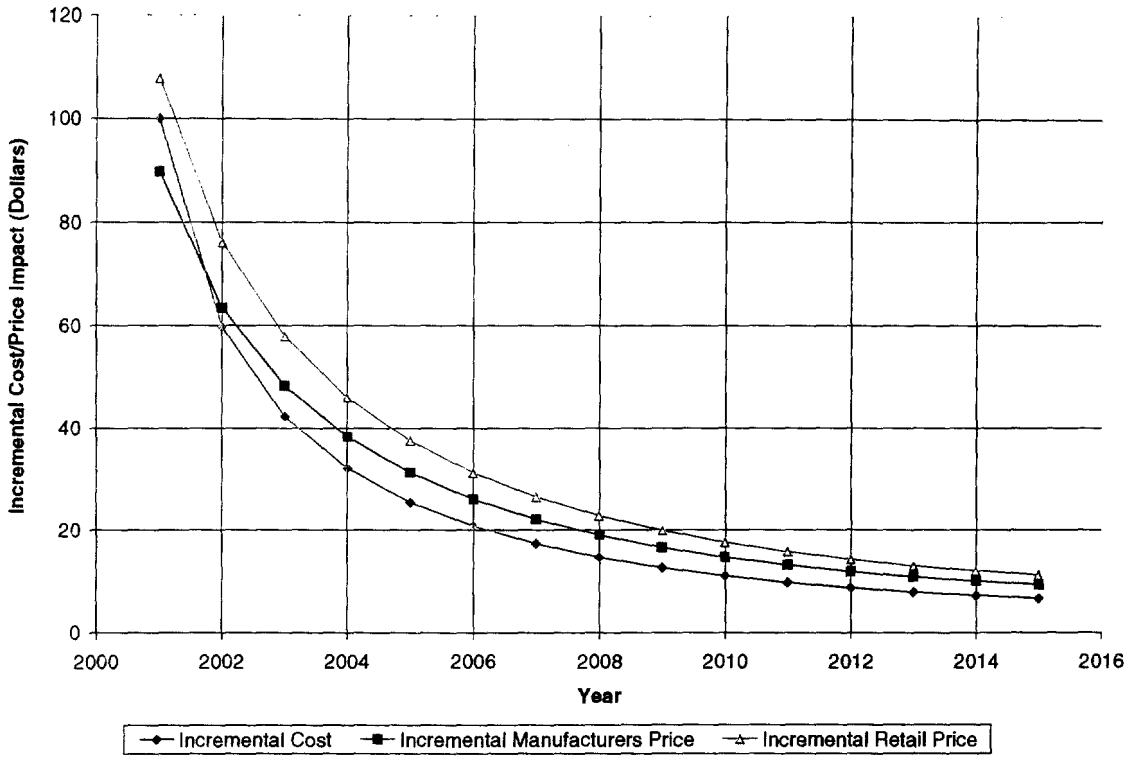
5.3.1.3 Impact on Manufacturer Price and Retail Price with 1 Year Forward Pricing

Under the assumption that manufacturers adopt a 1-Year Forward Pricing strategy, the price impact curve presented in Figure 5-8 is obtained.

As shown in Figure 5-8, a 1-year Forward Pricing strategy would result in a dramatic reduction in the estimated retail price. This is particularly true in the initial years. For example, in year 2001, the estimated price decreases from $180 to $108, i.e. a 41% decrease under this assumption. As for 2004, the estimated price would decrease from $58 to $46, a 21% decrease.

Please note that the forward pricing has the same impact on retail pricing under the FCC mandate scenarios which we will discuss later in Section 5.3.4 and 5.3.5 of the report.

Figure 5-8 Estimated Impact on Manufacturer and Retail Price Assuming 1-Year Forward Pricing



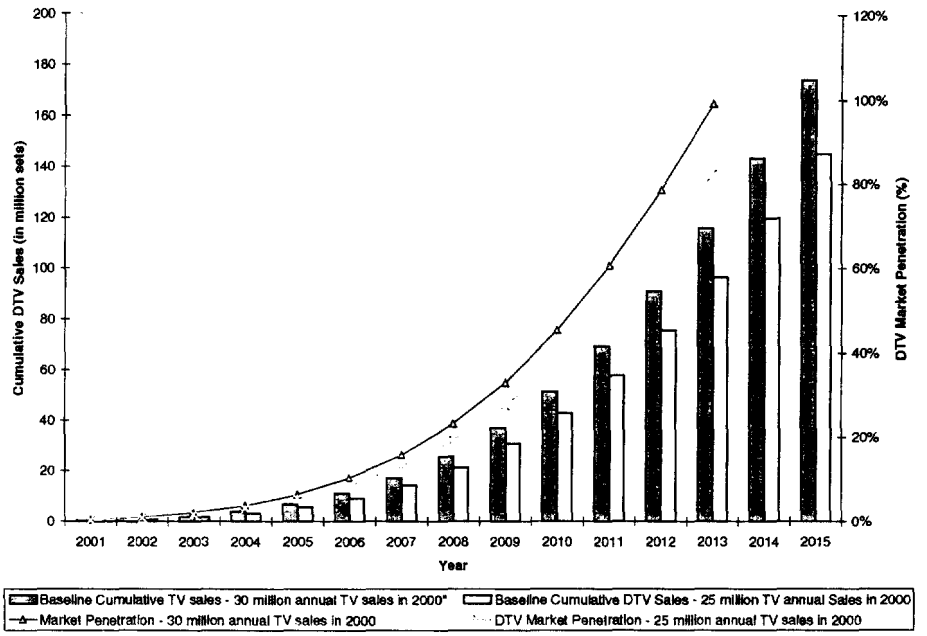
5.3.2 Sensitivity Analysis

To explore the dependence of the conclusions on key assumptions, the model results are presented under variations in the assumed annual TV sales, TV sales growth rate and incremental material cost.

5.3.2.1 Variance in annual TV Sales in Year 2000

If we include 5 million extra TV/VCR combination sales in year 2000 [CEA, 2001b], or about 20% increase from the above 25 million annual TV sets sales as we assumed above, the total annual TV sales will therefore be 30 million in 2000. Keeping all the other assumptions the same, the impact on our DTV sales and market share forecast under the three scenarios is shown in Figure 5-9 and summarized as follows:

Figure 5-9 DTV Sales and Market Share Forecast under 30 million v.s. 25 million Annual TV Sales in 2000



- DTV Sales:

  The cumulative DTV sales would increase by 20% for each year under 30 million annual TV sales assumption in year 2000. For example, the first year 2001 DTV sales will increase from previous 0.21 million sets to 0.25 million, a 20% increase. The cumulative DTV sales in 2006 would be 11.16 million vs. 9.6 million sets, also a 20% increase. The reason is that we have applied the same Bass Adoption rate for each year, which is decided by the same parameters, on the annual TV sales for each year.

- Market Penetration:

  Assuming the US TV households maintain the same in the two annual TV sales cases, the 20% increase on DTV sales each year will increase the DTV market penetration rate accordingly. As of year 2006, the DTV market penetration would increase from 8.5% to 10.2% under the new assumptions. The 85% target market penetration rate will be reached in 2013, one year earlier than in the previous case.

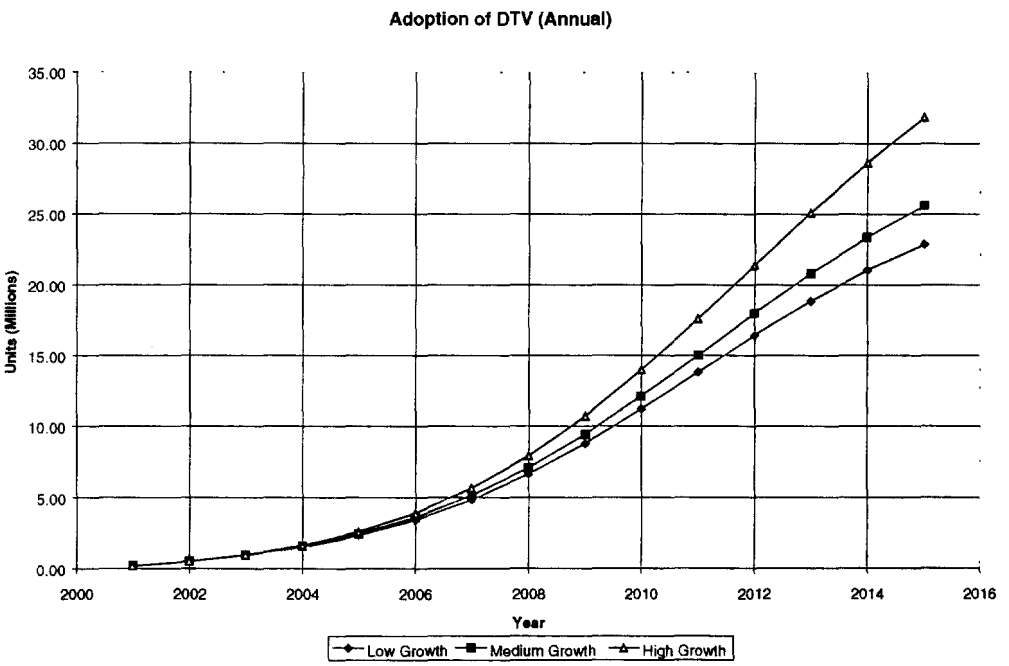
- Incremental Cost and Prices:

  The incremental cost will be the same under these two annual TV sales cases, since the cumulative sales increase at the same rate by year, the doubling rate in our learning curve would be the same, too. If we maintain the same retail markup, the retail price increases would maintain the same under new annual TV sales assumption.

5.3.2.2 Variance in Annual Sales Growth

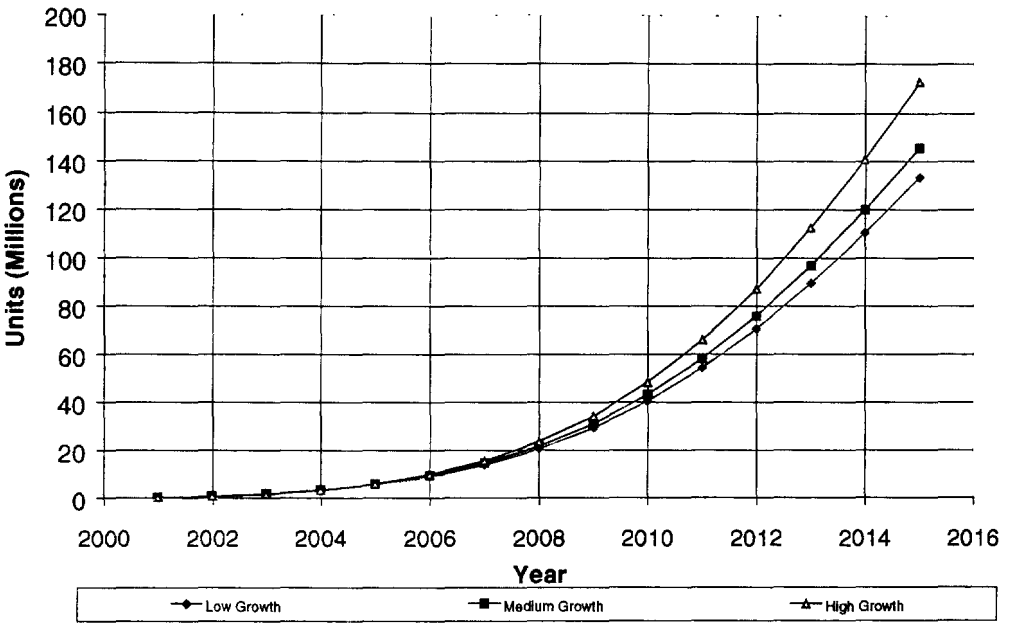
To examine sensitivity to the growth rate assumption, the model was run for low (0.75%), medium (1.5%) and high (3%) growth rate cases for annual TV sales. This results in the results presented in Figure 5-10 for annual sales projections and Figure 5-11 for cumulative sales projections.

Figure 5-10 Estimated Adoption of DTV versus Assumed Growth Rate Scenario



Considering low and high growth rate assumptions, the cumulative DTV sales forecast would range from 9 million to 10 million in 2006 under the baseline free market adoption scenario. Assuming 109.3 million TV households [Carmel Group, 2001a], estimated DTV penetration rates range from 8% to 9%. Thus, the FCC's 85% target adoption objective would not be realized until 2013, even under the high sales growth rate assumption.

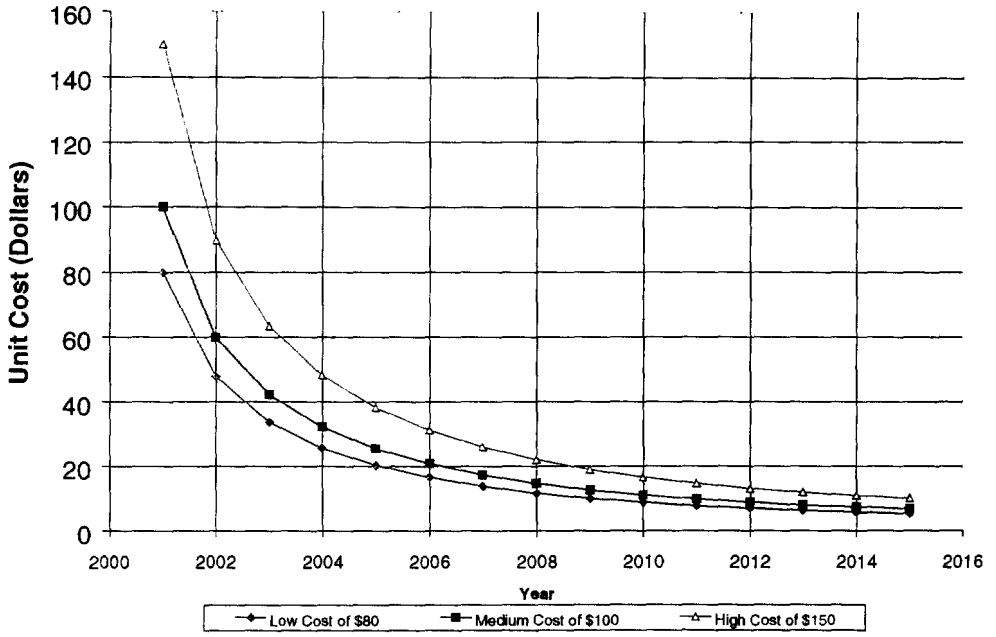
Figure 5-11 Projected Cumulative Sales versus Growth Rate



5.3.2.3 Variance in Incremental Cost

Assuming a range of incremental cost assumptions (low ($80), medium ($100) and high ($150)) for incorporation of a DTV receiver in newly manufactured consumer TV sets, the cost projections of Figure 5-12 are obtained. The DTV incremental cost as of 2006 would be in the range of $16.7 to $31.3 per TV set.

Figure 5-12 Projected Unit Cost versus Assumed Initial Incremental Cost



Considering the effects of the assumed markups, the estimated impact on manufacturer price is as shown in Figure 5-13. Also introducing the assumed retail price markup results in the estimates presented in Figure 5-14.

Figure 5-13 Estimated Impact on Incremental Manufacturer's Price versus Assumed Initial Incremental Cost

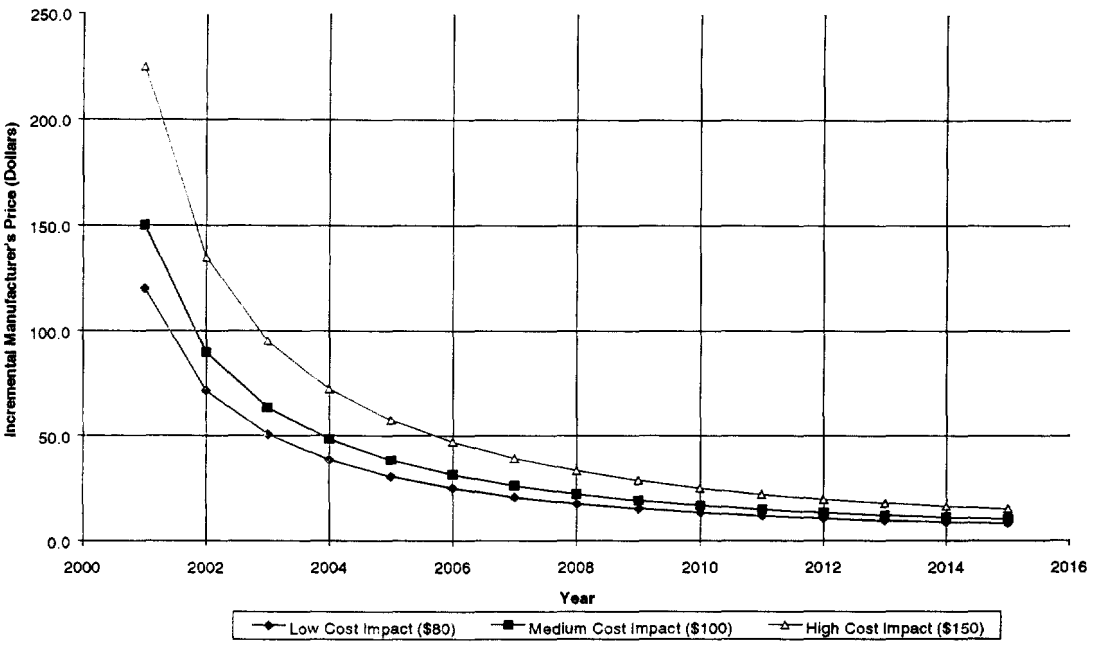
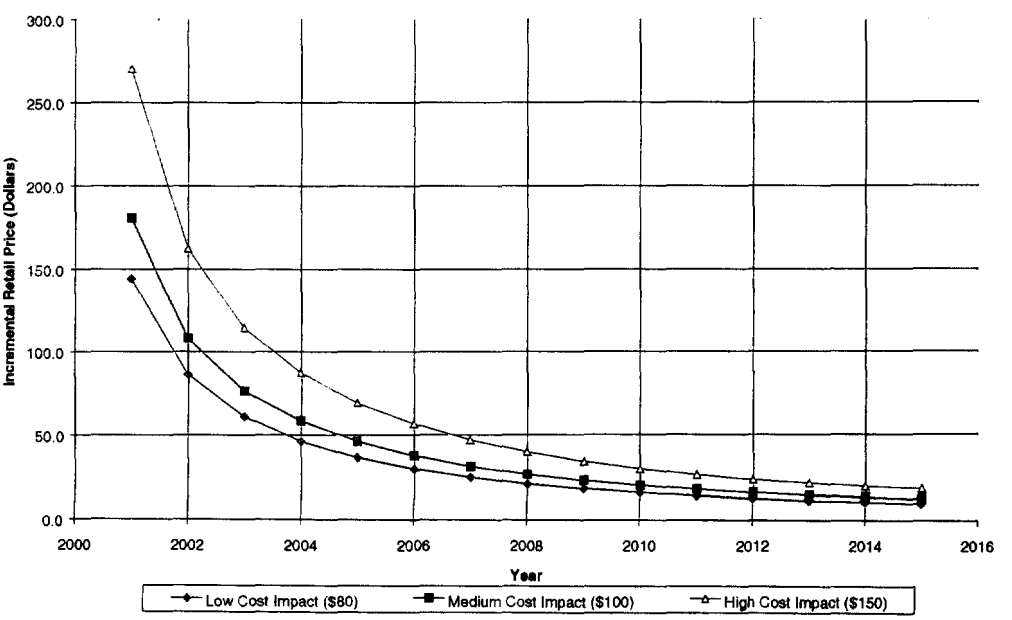


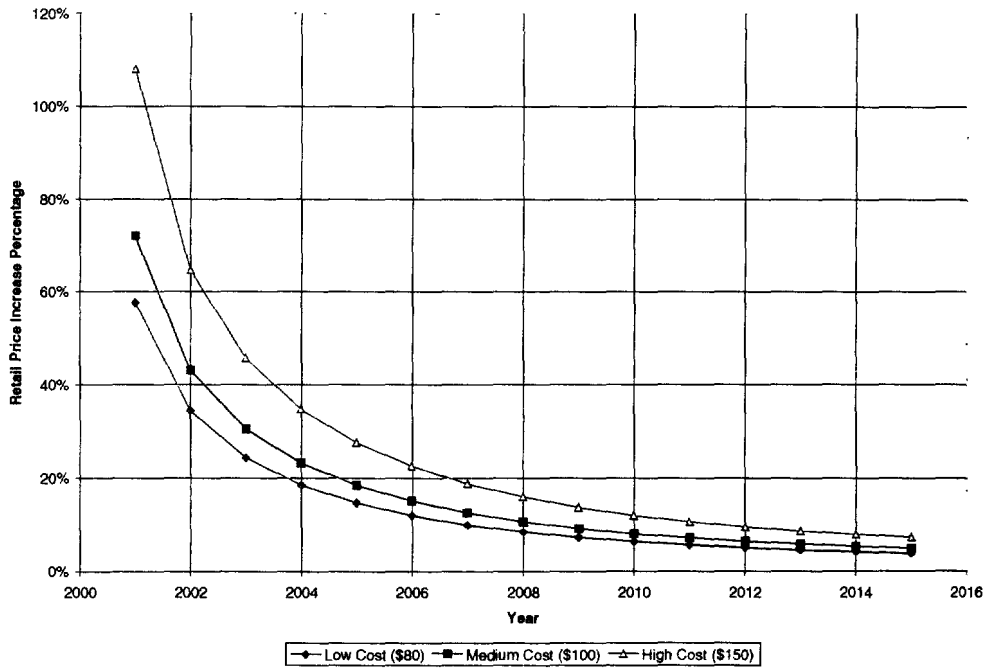
Figure 5-14 Estimated Impact on Retail Price versus Assumed Incremental Cost



The effect of varying the initial direct material cost ($80, $100 or $150) results in incremental retail price would be from $30 to $56 in year 2006. If a forward pricing policy were assumed, the predicted effect on retail price would be smaller.

Assuming the average analog TV retail price is about $250 over the study period, the retail price increase in percentage related to adding a DTV receiver under different cost scenarios are shown in Figure 5-15. The initial percentage increase may be high, especially under high incremental cost ($150) scenario, however, these percentages will quickly drop to 12%-23% in year 2006, close (or within) the 20% "customers indifference" as suggested by the retailer manager of a leading consumer electronics [Tweeter etc., 2001].

Figure 5-15 Baseline Case Retail Price Increase Percentage



5.3.3 Summary of Baseline Analysis

Table 5-1 summarizes the results of the Baseline Scenario (free market adoption scenario).

Table 5-1 Summary of Results for Baseline Scenario

Year	Annual DTV Sales (million units)	Cumulative DTV Sales (million units)	Incremental Cost/Unit ($)	Incremental Retail Price/Unit ($)	US TV Households	US Household DTV Penetration Rate
2001	0.21	0.21	100	180	104.0	0.2%
2002	0.52	0.73	60	108	105.0	0.7%
2003	0.96	1.69	42	76	106.0	1.6%
2004	1.58	3.27	32	58	107.1	3.1%
2005	2.44	5.71	26	46	108.2	5.3%
2006	3.60	9.30	21	38	109.3	8.5%
2007	5.13	14.43	17	31	110.3	13.1%
2008	7.06	21.49	15	26	111.4	19.3%
2009	9.40	30.89	13	23	112.5	27.5%
2010	12.08	42.97	11	20	113.6	37.8%
2011	14.98	57.94	10	18	114.8	50.5%
2012	17.92	75.87	9	16	115.9	65.4%
2013	20.75	96.62	8	14	117.1	82.5%
2014	23.32	119.94	7	13	118.3	N/A
2015	25.57	145.51	7	12	119.4	N/A

As Table 5-1 shows, the first year DTV sales is about 0.21 million sets in 2001, with incremental manufacturing cost of $100. The shaded entries highlight the key figures for the year 2006 when the FCC plans to achieve its target of 85% penetration. As shown, the cumulative sales are projected to be in the vicinity of 9.3 million units at an incremental retail price of $38 in 2006. Relative to a projected installed base of 109.3 million TV households [Carmel Group, 2001a], this corresponds to a penetration of 8.5 percent, which is well below the target penetration. Please note that as we mentioned in Section 4.2 Key Assumptions, due to limitations in available data, we have assumed the penetration rate of DTV technology as the ratio of DTV sales to US TV households. We do not include penetration rates in 2014 and 2015 since multiple DTV sales to one household may happen starting in those years.

5.3.4 Mandate Scenario

In this scenario, it is assumed that the FCC issues a mandate to incorporate a digital TV receiver in all sets sold [manufactured] as of a specified date. For purposes of this analysis, it is assumed that the date for mandatory implementation is January 1, 2004. All other analysis assumptions are the same as for the Baseline Scenario presented in Section 5.3.1. of this report.

Applying these assumptions to the cost model yields the sales and cost projections presented in Figure 5-16 and Figure 5-17.

Figure 5-16 Projected Unit Sales under Government Mandate Scenario

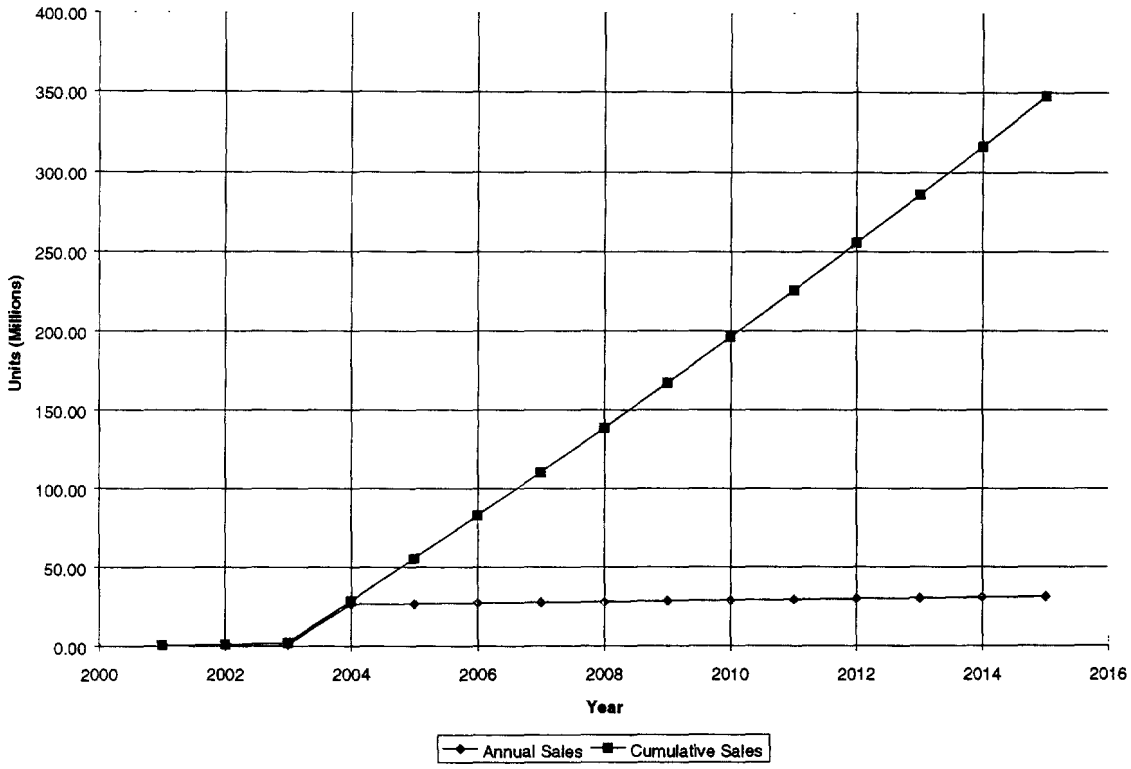
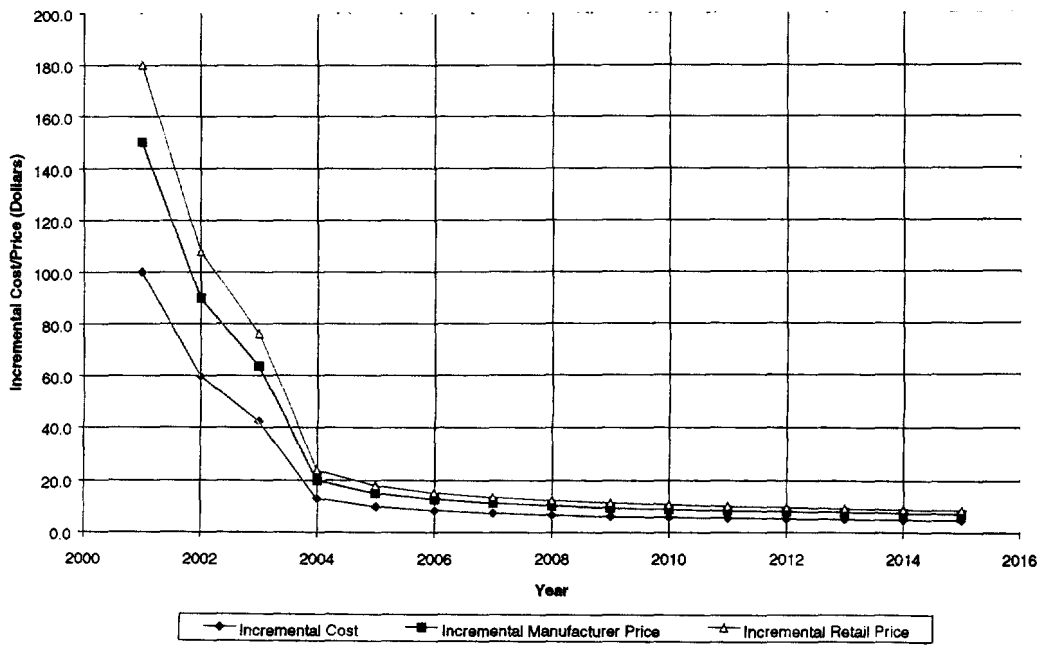


Figure 5-17 Estimated Impact on Cost and Price under FCC Mandate Scenario



As shown in Figure 5-16, assuming an FCC "cut-off date mandate", the estimated cumulative DTV sales would reach 82.5 million units in 2006. Assuming that in 2006, the number of U.S. TV owning households is approximately 109.3 million [Carmel Group, 2001a], the DTV household penetration rate would be 82.5/109.3 or 75.5%. In this scenario, the FCC's 85% target penetration rate is realized in 2007.

From this analysis, it is seen that the estimated incremental price falls more rapidly than in the baseline scenario due to the increase in DTV sales resulting from the government mandate. Specifically, the cost is projected to decrease from $100 in 2001 to $8.4 in 2006. The corresponding increment in retail price would also decrease to $15 by 2006. This is a substantial reduction over the 2006 cost and price estimates of $21 and $38 that were respectively projected for the baseline scenario.

5.3.4.1 Summary of Results for FCC Mandate Scenario

The results of the analysis for the FCC mandate scenario are shown in Table 5-2.

Table 5-2 Summary of Results for FCC Mandate Scenario

Year	Annual DTV Sales (million units)	Cumulative DTV Sales (million units)	Incremental Cost/Unit ($)	Incremental Retail Price/Unit ($)	US TV Households*	US Household DTV Penetration Rate
2001	0.21	0.21	100.0	180.0	104.0	0.2%
2002	0.52	0.73	59.8	107.7	105.0	0.7%
2003	0.96	1.69	42.3	76.1	106.0	1.6%
2004	26.53	28.23	13.1	23.7	107.1	26.4%
2005	26.93	55.16	10.0	17.9	108.2	51.0%
2006	27.34	82.49	8.4	15.2	109.3	75.5%
2007	27.75	110.24	7.5	13.4	110.3	99.9%
2008	28.16	138.40	6.8	12.2	111.4	N/A
2009	28.58	166.99	6.3	11.3	112.5	N/A
2010	29.01	196.00	5.9	10.6	113.6	N/A
2011	29.45	225.45	5.5	10.0	114.8	N/A
2012	29.89	255.34	5.3	9.5	115.9	N/A
2013	30.34	285.68	5.0	9.1	117.1	N/A
2014	30.79	316.47	4.8	8.7	118.3	N/A
2015	31.26	347.73	4.6	8.3	119.4	N/A

In Table 5-2, the shaded rows highlight the key figures for 2004, the year proposed for the introduction of a mandate and 2006, the target year to realize 85% TV household penetration. As shown, the TV household penetration in 2006 will be 75.5% under this scenario, assuming that each DTV sale corresponds to a new household adopting DTV. Again, we do not include the penetration rates for 2008 and later due to higher DTV sales would lead to multiple sales to one household.