More evidence of the Model's lack of external validity is provided by other cost models. We have observed that the cost estimates produced by the Hatfield model are far below those produced by any other cost model. A recent edition of Telecommunications Reports contrasted residential universal service costs produced by three proxy models: the Hatfield model 2.2.2, the Cost Proxy Model (CPM), and the Benchmark Cost Model 2 (BCM2). CPM is sponsored by Pacific Telesis (and adopted by the California Public Utilities Commission in its Universal Service Proceeding) and BCM2 is sponsored by U.S. West and the Sprint Corporation. The Telecommunication Reports comparison revealed that the costs predicted by the Hatfield Model are substantially lower than those predicted by the other two models. CPM and BCM2 produce relatively similar cost results with BCM2 costs being 10.9% lower, nationally. The Hatfield model's cost estimates, however, are 20 to 62 percent lower than CPM estimates.[19]

C. Modeling Problems

The Hatfield Model reports results for several network components: (1) loops, (2) local switching, (3) signaling, (4) transport, and (5) operator systems. Because the first two components constitute a substantial proportion of the total cost (over 90 percent in the states we have examined) and typically have been subject to more extensive examination in arbitration proceedings than the other components, our review focuses on these components.

1. Loops

Telecommunications Reports, October 28, 1996, p. 19.

For the most part, the Hatfield Model's development of loop costs relies on BCM Plus, an incompletely documented revision to the Benchmark Cost Model (BCM). The original model (BCM1) has been filed with the FCC by MCI, NYNEX, Sprint, and U.S. West. BCM1 identified geographic areas where the costs of basic residential access service are relatively high or low. The sponsors describe their model as follows:

> The BCM does not define the actual cost of any telephone company, nor the embedded cost that a company might experience in providing telephone service today. Rather, the BCM provides a benchmark measurement of the relative costs of serving customers residing in given areas, i.e., the CBGs [Census Block Groups].[20]

What is noteworthy about this description of purpose is that the costs that the BCM produces are not the actual costs of any particular company. Despite this acknowledgment by the BCM's sponsors, the proponents of the Hatfield model incorrectly propose to use parts of the BCM, albeit revised, to produce actual prices for the incumbent ILEC's unbundled elements.

The BCM (and thus the Hatfield Model) starts with the current locations of the ILEC's wire centers. The model constructs loop plant (feeder, distribution, and associated structures) from the wire center locations to the customer premises in the CBG by means of specific engineering rules, e.g., the lines served by a particular wire center are the result of assigning CBGs to the closest wire centers (see Section I C for more details on engineering rules).

[20] MCI Telecommunications Corporation, NYNEX Corporation, Sprint Corporation, and US West Inc., "Benchmark Cost Model," Submitted to the FCC, CC Docket No. 80-286, September 12, 1995, p. 3.

This assignment does not necessarily assign the households within the CBG to the wire center that actually serves them. For example, Pacific Bell, in California, and GTE in California and many other states have found that the Hatfield Model assigns substantial percentages of households to the wrong wire center.

Moreover, in most states it does not even use the correct set wire centers. In Texas for example, the Hatfield Model omits 58 of 545 wire centers and includes 4 extraneous ones. As a result of these errors, the network represented by the Hatfield Model significantly departs from the ILECs' actual network. Release 3.0, for the state of Texas, omits 87 wire centers and includes 7 extraneous ones. In California, we observed that Release 3.0 omits 9 wire centers among 278 and includes 5 wire centers that do not belong to GTE.

The Hatfield Model's proponents may argue that the Model has assigned households more efficiently than the ILECs have. A more likely explanation is that the extremely abstract representation of the network—a featureless plain[21]—ignores real world constraints, such as physical barriers, e.g., freeways, stadiums, rivers, lakes, and hills, between a CBG and its closest wire center. The Model also ignores possible non-physical right-of-way barriers.

Because the Hatfield Model assumes that loop facilities are installed instantaneously, it selects the largest available cable sizes to serve a given static volume. In contrast, because real networks evolve as demand grows and changes, firms face a trade-off between deploying larger cable sizes (and enjoying the economies of scale) versus using smaller sizes, thus reducing the

[21] The only distinguishing characteristics are a number of surface soil conditions used to estimate the cost of installation and support structures.

carrying costs of the extra inventory that large cable sizes entail. In this regard, the Hatfield Model underestimates cost of loop, because it assigns less facilities than an efficient firm would deploy. Such "savings" are illusory, not real. What has been left out of the Hatfield Model is the carrying charges such as the unused capacity that larger cable sizes would require for an optimal number of years, as the extra demand continuously materializes. These types of carrying charges are necessary when there are high demand shock adjustment costs as discussed in Section II A.

a. Loop Structure Cost Share Factors

The Hatfield Model arbitrarily assigns a telephone company a share factor of 0.33 for aerial, underground and buried structures of distribution and feeder systems. In fact, presently there is minimal or no sharing of the underground and buried telephone structures and the aerial sharing percentage is much smaller than the 67% implied by Hatfield Model's 0.33 share factor. By advocating the share factor of 0.33, the Model not only ignores but also disregards the present configuration of the local telephone network and achievable configuration in the near future.

The Model assumes that electric utilities, cable television and possibly competitive access providers and inter exchange carriers share the structure costs of the feeder and distribution components of a telephone network. In actuality, only a minute percentage of the aerial component of telephone distribution (e.g. pole investment) currently has the possibility of sharing costs with cable TV. Telephone and power lines do not share common trenches or conduits because of their incompatible nature. There is no sharing of costs for the buried and underground components of the feeder and distribution system.

In Release 3.0 the sharing factor of 0.33 has been modified according to different densities zones and the medium in which structures are built: aerial, buried, or underground. Interestingly, the aerial sharing factor decreased to 0.25 in most density zones and buried and underground sharing factor has remained the same or increased to 0.40. Overall cost is not affected significantly by the changes in sharing parameters in the new version of the model.

b. Modeling Distribution Facilities

The Hatfield Model constructs feeder plant from the wire center to a point half way into the center of a CBG. In Release 3.0 copper feeder plant terminates half way into a CBG but fiber feeder plant terminates at the center of a CBG. For calculating purposes the Model assumes that CBGs are square in shape and that households are uniformly distributed over the area of the CBG, neither of which is true of real CBGs. The Model also uses an abstract representation of the distribution plant within a CBG. CBGs in the same density class have the same number of distribution cables of length equal to 62.5 percent of the square-root of the area of the CBG.[22] The size of cable is determined by CBGs' access line density.

This abstract representation of distribution plant can produce results that differ from reality, i.e., loop lengths can be inaccurate, cable sizes can be incorrect, and the number of cables within a CBG can differ from the number of cables assigned by the Hatfield Model. Moreover, in contrast to actual engineering practice, the Model does not use tapered distribution cables. Instead it often runs a large pair cable (e.g., 200 pair) to the drop for each household along the distribution route. In actual practice, the cable gets smaller as it progresses

from the wire center, but also breaks into many more sub routes than predicted by Model. By predicting too few cables of too large a size it underestimates the number of sheath feet of cable needed and therefore the amount of trenching conduit or other structure required, while over estimating the size of the cable needed. The effect of both errors on cost is to understate cost. In the case of too large a cable, the Model predicts economies of scale that simply do not exist.[23] In the case of too few cables it under estimates the sheath feet of cable needed.

c. Fill Factors[24]

Because telephone capacity is modular, i.e., it comes in sizes greater than a single unit, there is more capacity in place than volume in service. Similarly, because of economies of scale in construction, it is efficient to install more capacity than currently needed and allow the network demand to grow into the installed capacity. Capacity exceeds volume even when the most efficient engineering practices are followed. The ratio of volume in service to capacity is the fill factor.

The spare capacity represented by a fill factor less than 1.0 is a *current* economic cost of providing service. In a previous evaluation of the BCM, Pacific Bell's cost experts reviewed

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(...continued)

[22] The model assumes that CBGs are square. Therefore, the square root of the area is the side of the square.

[23] Note that two one hundred pair cables cost more than one two hundred pair cable

[24] A theoretical discussion of these issues appears in Richard D. Emmerson, "Theoretical Foundation of Network Costs," in W. Pollard, editor, *Marginal Cost Techniques for Telephone Services*, National Regulatory Research Institute, 1991, pp. 145-189. See also Gregory M. Duncan, "The Effect of Probabilistic Demand Structures on The Structure of Cost Functions", *Journal of Risk and Uncertainty* (1990), 3, 3, 211-220.

that model.[25] As part of that review of the BCM engineering rules, Pacific's experts compared the model's fill factors with the actual fill factors that would result from the best engineering practices. In general, the fill factors for feeder plant in the BCM were moderately higher than best practice and the fill factors for distribution plant in high density areas were substantially higher than best practice. Distribution fill factors are relatively low because of the high cost of adding capacity after the support structure has been built. Accordingly, capacity for an indefinitely long planning horizon is installed initially and utilization of that capacity is low as a result.

As a further note on fill factors we would point out that there is no one optimal fill factor. The optimal fill factor will depend on growth rates, interest rates, modularity, uncertainty and depreciation. We also note that properly modeled fill factors increase over time as demand increases to fill capacity. The Hatfield Model, because of its static nature is unable to capture any of these aspects of fill.

Unfortunately, the somewhat high distribution fill factors in the original BCM were increased in the Hatfield Model and increased even further in the Release 3.0. As shown in Table 5 below the new version of the model has separated the fiber feeder into another fill factor category and increased the fill factors in that category to 100%. These changes in fill factor assumptions cause the underestimation of loop costs to be even greater.

[25] Timothy J. Tardiff, "Evaluation of the Benchmark Cost Model," prepared on behalf of Pacific Bell, for filing with the California Public Utilities Commission, Rulemaking/Investigation on the Commission's Own Motion into Universal Service and to Comply with Mandates of Assembly Bill 3643, R.95-01-020/I.95-01-021, December 1, 1995.

Table 5

Fill Factor Comparison
BCM vs. HM2.2.2 vs. HM3.0

Line Densities (lines/sq.mi).		Feeder				Distribution			
BCM & HM2.2.2	HM3.0	BCM	HM2.2.2	HM3.0 Copper	HM3.0 Fiber	BCM	HM2.2.2	HM3.0 Copper	HM3.0 Fiber
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0-5	0-5	0.65	0.65	0.65	1.00	0.25	0.50	0.50	n/a
5-100	5-100	0.75	0.75	0.75	1.00	0.35	0.55	0.55	n/a
200-650	100-200	0.80	0.80	0.80	1.00	0.45	0.60	0.55	n/a
	200-650	n/a	n/a	0.80	1.00	n/a	n/a	0.60	n/a
650-850	650-850	0.80	0.80	0.80	1.00	0.55	0.65	0.65	n/a
850-2550	850-2,250	0.80	0.80	0.80	1.00	0.65	0.70	0.70	n/a
2500+	2,550-5,000	0.80	0.80	0.80	1.00	0.75	0.75	0.75	n/a
	5,000-10,000	n/a	n/a	0.80	1.00	n/a	n/a	0.75	n/a
	10,000+	n/a	n/a	0.80	1.00	n/a	n/a	0.75	n/a

Note: n/a denotes not applicable.

The Hatfield Model's use of unrealistically high fill factors causes costs to be understated because the fill factor, in part, determines how much cable is needed. The Model appears to be based on the belief that competitive firms should have minimal spare capacity. In this regard, the FCC's finding on spare capacity in interstate long-distance, which was one of the bases for granting AT&T non-dominant status, contradicts this apparent belief:

> AT&T asserts, and no one disputes, that MCI and Sprint alone can absorb overnight as much as fifteen percent of AT&T's total 1993 switched demand at

> no incremental capacity cost; that within 90 days MCI, Sprint, LDDS/Wiltel, using their existing equipment, could absorb almost one-third of AT&T's total switched capacity; or that within twelve months, AT&T's largest competitors could absorb almost two thirds of total switched traffic for a combined investment of $660 million. Thus, AT&T's competitors possess the ability to accommodate a substantial number of new customers on their networks with little or no investment immediately, and relatively modest investment in the short term. We therefore conclude that AT&T's competitors have sufficient excess capacity available to constrain AT&T's pricing behavior.[26]

To cast the FCC findings in terms relevant to the current discussion, note that MCI and Sprint combined are roughly one-half of AT&T's size. Overnight they can absorb 15 percent of AT&T's capacity. This implies that MCI and Sprint together have at least 30 percent spare capacity that could be deployed overnight. The implication of these findings is that, uncertainty accompanying competition may result in more rather than less spare capacity if it requires firms to be flexible enough to respond to the vicissitudes of the market.

d. Terminal and Splice, Drop Wire, and Network Interface Device (NID)

In the Hatfield Model investments for terminal and splice, drop wire, and network interface device (NID) are left out for special access and pay phone lines. Page 31 of the Hatfield Associates' *Model Description* reports: "The drop and terminal/splice values are added for each line directly. The model computes one NID per household and one for every four (a user-adjustable value) business lines." In fact, while the description above may leave the impression that NIDs are treated differently, the same sharing across households and every four

[26] Federal Communication Commission, In the Matter of Motion of AT&T Corp. to be Reclassified as a Non-
(continued...)

business lines is used for the terminal/splice and drop wire investments. More important, the model includes no terminal/splice, drop wire, and NID investment for special access lines and pay phone lines.

Some indication as to how the Hatfield Model's developers intended to handle special access and pay phone lines is available from Dr. Robert Mercer's deposition in Texas, where it was suggested that special access lines were treated the same as business lines (one terminal/splice, drop wire, and NID four every four lines) and that there was one terminal/splice, drop wire, and NID for every pay phone line.[27]

In some states, the Hatfield Model proponents have reported separate unit costs for the NIDs. These unit costs are based on dividing the costs associated with NIDs for residential and business lines by the total number of lines, *including special access and pay phone lines*. Thus, the unit costs are understated by the ratio of total lines to the sum of residential and business lines.

2. Switching

The Hatfield Model systematically understates the cost of local switching. By selectively using heavily discounted prices for new switches and by assuming that a local service provider would instantly install all of the switching capacity it needs at once, the

(...continued)

Dominant Carrier, FCC 95-427, October 15, 1995, paragraph 59.

[27] Oral Deposition of Robert A. Mercer, Before the Public Utilities Commission of Texas, Docket no. 16226 and 16285, Vol. 2, p. 217.

Hatfield model produces costs that are substantially lower than the forward-looking local switching costs that real telephone providers actually incur.

The Model creators developed a relationship between switching cost per line and the size of the switch by piecing together information from various sources. In particular, the algorithm is driven by three data points constructed as follows.[28]

- Small switch: the cost per line ($220 for 1995) is taken from forecasts found in the Northern Business Information report[29] on the estimated 1995 average cost of *new* lines for independent companies. The model associates the average *installed* switch size of 2,761 lines with small LECs (i.e., the LEC industry less the Regional Bell Operating Companies or "RBOCs"), calculated from 1993 statistics on lines and switches reported to the FCC.[30]

- Medium switch: the cost per line ($86 for 1995) is taken from forecasts found in the Northern Business Information report on the estimated 1995 average cost of *new* switches for RBOCs. The model associates the average *installed* switch size of 11,200 with RBOCs, calculated from 1993 statistics on lines and switches reported to the FCC.

- Large switch: cost per line of $59 for a 80,000 line switch in 1995, obtained from an unnamed expert.

The Model creators then connected the three points with straight lines to determine a relationship between switch price and switch size.

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[28] The switching cost function is described in some detail in the documentation for Release 1. The prices for the three switch sizes appear to be lower in Release 2. No justification for the lower prices has been provided.

[29] Northern Business Information, *US Central Office Equipment Market—1995*, McGraw-Hill.

[30] Federal Communications Commission, *Statistics of Communications Common Carriers*, Tables 2.3 and 2.4.

The Model's approach to determining the switch cost function suffers from two problems. First, there is a mismatch between the data sources it employs: the model matches a 1995 forecasted price with a 1993 average embedded switch size. In addition, while the model uses independent ILECs (*not* including GTE) to calculate the small switch price, it, nevertheless, includes GTE in the calculation of the average size of a small switch. Second, the model assumes that the average *installed* switch is of the same size as the average *new* switch, an assumption that is not necessarily valid.

Comparison of the Model's switch cost assumptions to actual GTE switching cost data in California is instructive. GTE provided data on 53 competitive switch contracts during the period 1989 to 1994. Statistical analysis on the data gave a best fit relationship of

$$C_G = C/L = \$97.30 + \$781{,}599/L,$$

where C=cost of switch and L=number of lines. Variables such as year, type of switch, host/remote and so on were insignificant. One can usefully fit the same type of relationship to the 3 Hatfield Model's observation data points on cost of switch[31] and obtain the best fit relationship:

$$C_H = C/L = \$49.55 + \$461{,}033/L.$$

Astonishingly, the relationship between the two cost curves is

$$C_H = 0.558 * C_G$$

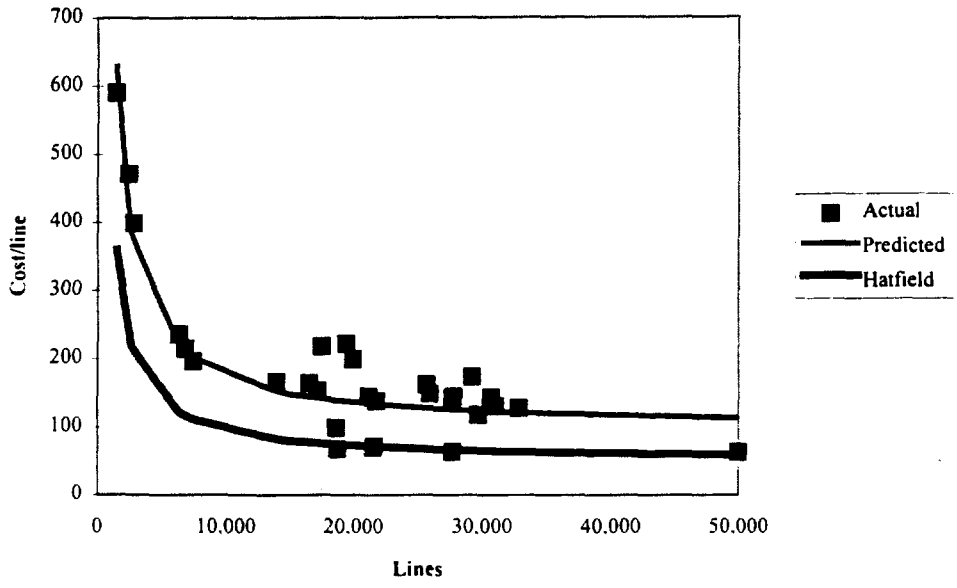
We obtained the above formula which shows the mathematical relationship between switch cost proposed by the Hatfield Model and GTE actual cost using GTE lines as data points

[31] *Model Description*, Op Cit. pp. 24-25.

and predicting C_H and C_G at each point. The R^2 between the predictions is nearly one, meaning that the switch cost of the Model is nearly identical to 60% of GTE's experience.

The Chart 1 below graphically illustrates the difference between the cost function used by the Model with that of GTE's actual cost function.

Chart 1



More fundamentally, the Hatfield Model ignores the fact that ILECs buy additional lines for installed switches as well as new lines for new switches. The additional lines for installed switches actually cost more, as the McGraw-Hill switch cost study used by the Hatfield model describes:

> The add-on market provides significant revenue potential for switch suppliers, particularly as the margins on new switches remain below the margins for the add-on market. A digital line shipped and in place will generate hundreds of dollars in add-on software and hardware revenue during the life of the switch. Suppliers can afford to lose a few dollars on the initial (new) line sale in

exchange for the increased revenue in the after-market, where prices are less likely to be set by competitive bidding.[32]

The local switching component of the Hatfield Model illustrates the fallacy of its scorched view of cost studies. In order for the approach to produce realistic costs (ignoring the data problems identified earlier), a new entrant would have to serve customers with initial lines only and also have the volumes to command the discounts that existing ILECs apparently command. The fact that ILECs expand their switches as demand grows and the existence of a lucrative aftermarket for this expansion demonstrate that the "instant LECs" posited by the Hatfield Model are inconsistent with reality.

The end office switching trunk port costs per line in Release 3.0 are even lower than in the previous version—they are 38% lower in Washington, 27% in California, and 49% in Texas.

D. Converting Investments and Expenses into Annual and Monthly Costs

The various manifestations of the Hatfield model are essentially models of the investment and expense components of ILECs' cost structure. These components are summed together and converted into annual and monthly amounts by (1) annualizing the investments through the use of cost-of-capital and depreciation rates and (2) estimating out-of-pocket operating expenses through the use of historical expense to investment ratios.

[32] Northern Business Information, *US Central Office Equipment Market—1994*, McGraw-Hill, p. 71.

In the case of investments, once the artificially low "forward-looking" network investment costs are calculated, the Model converts investments into annual amounts over the economic life of the investment. The model makes two errors in this calculation. First, it bases the return and tax gross-up calculation on the net plant at the end of the year, rather than the beginning of the year. For example, to calculate return and taxes for the first year, the model uses net investment after one year's worth of depreciation, rather than the (correct) initial investment. In addition, the Model uses a pre-tax, rather than an after-tax, discount rate in calculating present values and annualized amounts. These errors are repeated in the calculation process of capital costs in every year of relevant depreciable life of a plant, resulting in an understatement of approximately 3% of the total cost depending on the company.

Release 3.0 converts investment into annual amounts by basing the return and tax gross-up calculation on the net plant at the middle of the year. Although this modification in Release 3.0 mitigates the error in the Hatfield Model to a certain extent, the model still understates costs by incorrectly calculating annual investment costs. For a plant with a particular depreciation life (e.g., 20 years), the model follows the following steps in calculation a factor that converts the investment into a constant annual equivalent.

- Calculate the following series for the life of the investment: depreciation, return, plus income taxes. The return plus taxes component is calculated on a net base that is the average of the beginning and end of period net investments. For example, for the first year of a 20-year investment, the base is 97.5 percent of the initial value (100% + 95%)/2 and for the 20th year, the base is 2.5 percent of the initial value. The particular formula is:

$$annual\ value_t = depreciation + return_t = \frac{1}{Life} + pre-tax\ RoR\ (1 - \frac{t-0.5}{Life})$$

In the formula above, the pre-tax RoR is calculated by:

$$pre-tax\ RoR = \frac{\%\ Equity \times ROE}{(1 - Tax\ Rate)} + \%\ Debt \times Debt\ Interest\ Rate$$

For example, the Hatfield default values are the following:

% Equity: 55%

ROE: 11.9%

Tax Rate: 40%

% Debt: 45%

Interest rate: 7.7%

Therefore, the pre-tax RoR, which includes both return and the tax gross-up, is 14.37%.

- Calculate two present values for the series in the first step—the first present value has the first annual payment at the end of the first year and the second present value has the series beginning at the beginning of the first year. Note that the two present values differ by (1 + discount rate). The Hatfield model then takes a simple average of the two present values. The Hatfield model's discount rate is the following.

$$Discount\ Rate = \%\ Equity \times ROE + \%\ Debt \times Debt\ Interest\ Rate$$

- Calculate the levelized payment of the average of the previous steps in two ways—assume that the payment is made at the beginning and end of each year, respectively. The factor used to convert investment into annual amounts is the simply average of the two payments. Again the two payment estimates differ by (1 + discount rate). These factors apply to investments with integer lives.

- When the life is between two integers (e.g., 20.45 years), Release 3.0 takes a weighted average of the higher and lower integer lives. For example, for a 20.45 year life, the model averages 45 percent of the 21 year factor and 55 percent of the 20 year factor.

The Hatfield factors for integer lives can be calculated in a single step. Calculate the single payment for the Hatfield annual series using the conventional end-of-period formula for both the present value and levelizing steps. The Hatfield factor is the following.

$$Hatfield\ Factor = \frac{(1+\frac{r}{2})^2}{(1+r)}\ PMT(NPV)$$

The Hatfield approach differs from the standard finance text book treatment,[33] which would consider the initial investment to occur at the beginning of the first year and the annual depreciation, return, and tax components to occur at the end of each year of the life of the investment. In addition, (1) the annual amounts are based on the beginning-of-period net investments and (2) the discount rate is the after-tax rate of return. The after-tax discount rate is the following:

$$After-tax\ discount\ rate = pre-tax\ RoR \times (1 - tax\ rate)$$

The series of annual values (for the life of the investment) is the following.

$$annual\ value_t = depreciation + return_t = \frac{1}{Life} + pre-tax\ RoR\ (1 - \frac{t-1}{Life})$$

[33] *Principles of Corporate Finance*, Fourth Edition, Chapter 5, 1991, McGraw-Hill.

It turns out that the present value of the annual values is the following:

$$PV = \frac{Investment - PV(depreciation\ tax\ benefit)}{(1 - tax\ rate)}$$

The annual depreciation tax benefit is simply tax rate/Life.[34].

The present value is then levelized, using the end-of-period payment function and the after-tax discount rate.

The following schedule compares the Hatfield factors with the correct factors. The correct factors are generally greater than the Hatfield factors, especially for assets with short lives. Also note that the Hatfield factors have the counter-intuitive property that the factor *increases* between 19 and 20 years.

Life	Hatfield	Correct	Ratio
1	1.07430738	1.143733333	6.5%
2	0.574885487	0.609285395	6.0%
3	0.409172164	0.431794755	5.5%
4	0.326883398	0.343541753	5.1%
5	0.277961577	0.290981929	4.7%
6	0.245720171	0.256266694	4.3%
7	0.223007263	0.231746288	3.9%
8	0.206246432	0.213595524	3.6%
9	0.193450384	0.199689029	3.2%
10	0.183426408	0.188751349	2.9%
11	0.175415219	0.179970632	2.6%
12	0.168910381	0.172805467	2.3%

[34] The Hatfield Models implicitly assumes that tax depreciation is straight-line. Using accelerated depreciation would reduce the annual factor.

Life	Hatfield	Correct	Ratio
13	0.163561074	0.16688088	2.0%
14	0.159116537	0.161928898	1.8%
15	0.155392727	0.157752894	1.5%
16	0.152251488	0.154205297	1.3%
17	0.149587067	0.151173172	1.1%
18	0.14731713	0.148568608	0.8%
19	0.145376611	0.14632214	0.7%
20	0.145649747	0.144378144	0.9%
21	0.142285296	0.142691547	0.3%
22	0.141057721	0.141225439	0.1%
23	0.140002114	0.1399493	0.0%
24	0.139094664	0.138837677	-0.2%
25	0.138315375	0.137869177	-0.3%
26	0.137647339	0.137025686	-0.5%
27	0.13707617	0.136291773	-0.6%
28	0.13658956	0.13565421	-0.7%
29	0.136176924	0.135101597	-0.8%
30	0.135829119	0.134624064	-0.9%
31	0.135538217	0.134213022	-1.0%

1. Cost of Capital

The 10 percent default value of the Hatfield Model, although higher than that used in its earlier release, is too low for two reasons. First, the FCC's approved rate of return remains at 11.25 percent. Second, the whole premise behind Hatfield Model's cost estimates is that it estimates forward-looking costs using forward looking inputs. One of the effects of competition is to raise the riskiness, and therefore the cost of capital, of competing firms

(incumbents as well as entrants). This, in turn, increases the annual capital cost for local exchange services. This means the cost of capital required for a forward looking calculation is much higher than the regulated one.

As a very simple example consider the following scenario of increasing the uncertainty of an investment. An investor may invest $K now in a regulated firm and receive a guaranteed return of 0.11 next year. The expected future value of such an investment is 1.11*$K. Alternatively, the same investor can invest the same amount in a firm entering competition and receive the competitive return with probability 0.7 or only receive 0.65 of his or her original investment. The expected future value of this alternative is

$$0.7*(1+r)*K+(1-0.7)*0.65*K,$$

where r is the rate of return.

What rate of return will make the investor indifferent between the certain 0.11 return and the uncertain case? Assuming the investor is risk neutral, the required return can be calculated by equating the expected value of the uncertain outcome with the outcome of the certain case. Simple algebra shows that the required rate is .307, fully three times higher than the certain case. (Let f be the fraction recovered in the case of a loss, let r_c be the rate of return for the certain case, and let ρ be the probability of making a positive return, then $r = \frac{1+r_c}{\rho} - \frac{(1-\rho)f}{\rho} - 1$.) We note in passing the complications introduced by moving to more periods or considering a distribution of possible losses makes the problem harder. Such considerations were the basis of Dr. Hausman's May 30 1996 affidavit before the FCC.

2. Depreciation Rates

The Hatfield Model uses long depreciation lives in estimating the annual costs of network investments. While such long investment lives may have been appropriate for a regulated monopoly provider, the competitive environment fostered by the Telecommunications Act is a different world. The forces of competition itself, as well as the technological change that permeates this industry, invalidate the use of the old long depreciation lives. In fact, Professor Hausman's May 30, 1996 reply affidavit demonstrates that accounting for the increased risk and uncertainty of competition increases the annual cost related to investments by a multiple of at least 3.

The Hatfield Model lists asset lives by type of facility, e.g., end office switches have a life of 14.3 years in the model. In order to compare these depreciation lives with external sources, we have calculated a range of weighted average depreciation lives (by investment) of about 17 - 20 years, which is equivalent to an annual depreciation rate of about 5 to 6 percent. This rate is substantially lower than the 1994 book depreciation of 7.16 percent for RBOCs, let alone the higher true economic depreciation rate.[35]

[35] Federal Communications Commission, Statistics of Communications common Carriers, 1994/1995 Edition, Table 2.9.

Economic depreciation rates are much higher. For example, Schmalensee and Rohlfs reported that AT&T's depreciation rate is 18.5 percent.[36] Even AT&T's 1994 book depreciation rate of about 11 percent is higher than the rates used in the Hatfield model.

3. Common Costs

In its Version 2.2 Release 1, the Hatfield Model presents a regression analysis of common costs (support costs) regressed on direct costs (total costs as measured by total revenues minus support costs) to support a 10% factor to adjust for common costs. In release 2, the reference to the analysis is dropped and a 10% factor merely asserted. However, in AT&T arbitration with GTE California, Dr. Mercer, one of the sponsors of the model, defended the 10% factor using the regression analysis contained in the old and presumably superseded manual and documentation for Release 1.[37]

Common costs are not easily identified; they are costs over and above the costs attributable to specific elements in an economically meaningful fashion. Common costs for an ILEC should be its total costs minus all of its TELRICS. If the Model was calculating the TELRICS correctly it can simply subtract the sum of an ILEC's TELRICS from its total cost reported in ARMIS to arrive at the amount of common costs for that ILEC..

[36] Richard Schmalensee and Jeffrey H. Rohlfs, "Productivity Gains Resulting From Interstate Price Caps for AT&T," National Economic Research Associates, September 1992.

[37] Interestingly, Dr. Lee Selwyn presented the results of a similar analysis in the same arbitration to estimate the amount of avoided common cost and found a 18%-21% number. The difference in analysis seems to be in choice of firms to include and the year sampled (1994 for Selwyn 1995 for Mercer).

Overlooked in the debate over what should be the input value of the common cost factor is the issue of the Hatfield Model's mistaken notion that common costs are mostly expenses, rather than investment-related costs. Common costs include 67XX accounts reported in ARMIS which are expenses associated with corporate activities such as accounting and finance, procurement, information management, executive compensation and other general and administrative expenses. These 67XX expenses are, by their nature, variable in the short term. Arbitrarily reducing these costs to appeal to the forward looking concept is a mistake.

FCC staff has stated the following on what costs constitute forward-looking economic costs.[38]

> *Use of Forward-looking Economic Costs as a Basis for Pricing.* In dynamic competitive markets, firms base their actions on the relationship between market-determined prices and forward-looking economic costs. We define forward-looking economic costs as the costs that would be incurred if a new element or service were provided, or that could be avoided if an existing element or service were not provided, assuming that all input choices of the firm can be freely varied. This is often referred to as long-run economic cost. This "long run" approach ensures that rates recover not only those operating costs that vary in the short run, but also fixed investment costs that, while not variable in the short term, are necessary inputs directly attributable to providing the element or service.

Corporate and operational expenses certainly meet these criteria.

[38] *The use of Computer Models for Estimating Forward-Looking Economic Costs*, FCC Staff, Jan 1 1997 at para 9.

There are more fundamental shortcomings in the Hatfield Model's methodology of estimating common costs. First, the Hatfield approach is based on a classic error in logic, the fallacy of division[39]. The fallacy of division ascribes properties that hold for a group to each member of the group. Second, underlying its analysis is an implicit assumption about telecommunications firms that is certainly false; by positing a linear relationship between directly attributable costs and common costs it implicitly assumes that the stand alone costs of producing each service or element is totally volume insensitive.

The assumption has two implications: first, it implies the stand alone cost of providing loops for 20 customers is the same as the cost of providing them for 10,000; second, it implies that eventually telecommunications services will be provided by a set of natural monopolies, one for each element or service. Given the Model's linear structure, the TELRICs are also the stand-alone costs. This result says that if the Hatfield model adequately represents such a firm, its TELRICs should be volume insensitive as well. Thus if the regression were to be believed then it gives hard evidence that the Hatfield model does not model a real firm. This is somewhat of a non-issue since the regression analysis is worthless. Third, its data set, a single year of data on a subset of local exchange carriers, is incapable of determining the answer to the question it poses or the validity of its approach because it doesn't contain multiple observations on each firm to predict what happens to a specific firm when its direct costs vary. Fourth, it utilizes the wrong statistical technique, regression analysis, to identify a group relationship which it then mistakenly applies to the members of the group, ILECS, specifically.

[39] Shim, J.K. and Joel Spiegel, *Dictionary of Economics*, John Wiley and Sons, Inc. New York

The Hatfield Model suggests the following procedure to account for common costs. Using a sample of firms in a single year, it regresses an estimate of common costs (CC) on an estimate of direct costs (DC) (Hatfield Documentation of May 16, 1996 Version 2.2 Release 1, p. 51). It finds that the regression has a statistically insignificant value, and that the coefficient on direct costs is 0.12.

There are a number of problems with the Hatfield Model's analysis, any one of which renders all of its analyses useless. We begin with its approach. The Model would determine a relationship between direct and common costs that holds between firms, and then apply that relationship to each firm. Hatfield suggests that since a direct statistical relationship between CC and DC exists across firms, e.g. CC=a +bDC, that a reduction of $100 dollars in DC due to resale will result in a reduction of CC of b*100. This is the fallacy of division that we referred to above. To take the implications of this from the abstract to the specific and intuitive level, an analogy is in order.

A strong positive correlation exists between height(H) and weight(W) of males. This means that men who are taller tend to be heavier. If, for a sample of men, the authors of the Hatfield Model ran a regression of each man's height on its weight, it would obtain a positive coefficient on weight, just as they found a positive relationship between direct and joint costs.

For purposes of illustration, let us assume that it found that H=(1/30)W. Thus a man weighing 150# would be predicted to be 5' tall, a man weighing 180# would be predicted to be 6' tall. Applying Hatfield Model's approach to the height and weight analogy, it would assert a person going on a diet and losing 10# would get 4" shorter (4"=12"×(1/30)×10). The