

MacroEconometric Forecasting



Topic:

Forecast Uncertainty and Model Evaluation

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Learning Objectives

- Understand the principles of financial forecasting
- Prepare a revenue forecast for an established firm
- Prepare a sales forecast for a new venture using yardsticks and fundamental analysis
- Incorporate demand and supply considerations into the revenue forecast
- Estimate revenue uncertainty using sensitivity analysis, scenario analysis, and simulation



Benefits of Financial Forecasting

- Provides a disciplined means of evaluating the cash need of a venture
- Aids in determining whether a proposed venture deserves the entrepreneur's investment of capital and effort
- Allows comparison of strategic alternatives
- Helps the entrepreneur and investors understand the strengths and weaknesses of the venture
- Represents a benchmark for assessing project development



Overview of Financial Forecasting

- Financial modeling
 - Revenue forecast
 - Income statement forecast
 - Balance sheet forecast
 - Integration and cash flow forecast
- Revenue forecasting
 - Approaches
 - Naïve
 - Yardsticks
 - Fundamental
 - Information sources
- Forecasting uncertainty
 - Scenarios
 - Sensitivity
 - Simulation



Principles of Financial Forecasting

- Build and support a schedule of assumptions
- Begin with a forecast of revenue
- Decide whether to forecast in real or nominal terms
- Choose an appropriate time span and forecasting interval
- Integrate the financial statements
- Assess the reasonableness of the model



Forecasting Revenue of an Established Business

- May be able to develop a reliable revenue forecast based on its prior sales experience
 - average growth rates
 - weighting
 - trends
 - relation to economic and demographic factors

Example

<i>Year</i>	<i>-6</i>	<i>-5</i>	<i>-4</i>	<i>-3</i>	<i>-2</i>	<i>-1</i>
Sales (\$millions)	\$2.0	\$2.4	\$2.7	\$2.6	\$2.6	\$2.9
Sales growth		+20.0%	+12.5%	-3.7%	0.0%	+11.5%
Inflation		+3.0%	+6.0%	+7.0%	+4.0%	+2.0%
Change in real GDP		+3.0%	+1.5%	-1.0%	-1.0%	+2.0%



Naïve Forecasting

1. Extrapolate the nominal historical average
2. Extrapolate the real historical average
3. Weight more recent periods more heavily
4. Exponential smoothing
5. Tie to related variables that are forecasted



Forecasting Revenue of an Established Business

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Inflation		+3.0%	+6.0%	+7.0%	+4.0%	+2.0%
Change in real GDP		+3.0%	+1.5%	-1.0%	-1.0%	+2.0%

1. Historical nominal growth rate:

Average sales growth_{Years -5 to -1} = 8.06%

Sales forecast_{Year 0} = $(1 + 0.0806 \times \$2.9 \text{ million}) = \3.13 million

- Large variance in the historical annual growth rates



Forecasting Revenue of an Established Business

Year	-6	-5	-4	-3	-2	-1
Sales growth		+20.0%	+12.5%	-3.7%	0.0%	+11.5%
Inflation		+3.0%	+6.0%	+7.0%	+4.0%	+2.0%
Real sales growth		+17.0%	+6.5%	-10.7%	-4.0%	+9.5%

2. Historical real growth rate:

Average real sales growth $_{\text{Years } -5 \text{ to } -1} = 3.66\%$

Expected inflation $_{\text{Year } 0} = 1.0\%$

Forecasted nominal growth rate $_{\text{Year } 0} = 3.66\% + 1.0\% = 4.66\%$

Sales forecast $_{\text{Year } 0} = (1 + 0.0466 \times \$2.9 \text{ million}) = \$3.04 \text{ million}$

- May be more accurate if product prices follow inflation

Forecasting Revenue of an Established Business



3. Weighting historical growth rates:
- future will be more like recent history

<i>Year</i>	-5	-4	-3	-2	-1
Real sales growth	+17.0%	+6.5%	-10.7%	-4.0%	+9.5%
Weight factor	1/15	2/15	3/15	4/15	5/15
Weighted growth	+1.13%	+0.87%	-2.14%	-1.07%	+3.17%

- Forecasted real sales growth = sum of weighted growth = 1.96%
- Less than the simple average due to the small weight on Year -5

Forecasting Revenue of an Established Business



4. Exponential smoothing:

$$\text{Forecast}_{T+1} = \alpha \times \text{Actual}_T + (1 - \alpha) \times \text{Forecast}_T \quad (6.1)$$

- implicitly reflects data from before Year T

<i>Year</i>	<i>-5</i>	<i>-4</i>	<i>-3</i>	<i>-2</i>	<i>-1</i>	<i>Forecast</i>
Real sales growth	+17.0%	+6.5%	-10.7%	-4.0%	+9.5%	?
Forecast with $\alpha = 0.2$		+17.0%	+14.9%	+9.8%	+7.0%	+7.5%
Forecast with $\alpha = 0.6$		+17.0%	+10.7%	-2.1%	-3.3%	+4.4%

$$\begin{aligned} \text{Forecast}_0 &= \alpha \times \text{Actual}_{-1} + (1 - \alpha) \times \text{Forecast}_{-1} \\ &= 0.2 \times 9.5\% + 0.8 \times 7.0\% = 7.5\% \end{aligned}$$

Forecasting Revenue of an Established Business



5. Based on fundamentals:

<i>Year</i>	-5	-4	-3	-2	-1
Change in real GDP	+3.0%	+1.5%	-1.0%	-1.0%	+2.0%
Expected sales growth (×5)	+15.0%	+7.5%	-5.0%	-5.0%	+10.0%
Real sales growth	+17.0%	+6.5%	-10.7%	-4.0%	+9.5%
Difference	+2.0%	-1.0%	-5.7%	+1.0%	-0.5%

Expected real GDP growth $_{\text{Year } 0} = 1.5\%$

Forecasted real growth rate $_{\text{Year } 0} = 1.5\% \times 5.0 = 7.5\%$



Forecasting Revenue of a New Venture

- No prior track record of sales
- Two approaches to new venture forecasting
 - yardsticks
 - fundamental analysis

Forecasting Revenue of a New Venture: Yardsticks



- Yardsticks
 - established firms comparable to the new venture on some dimensions important to forecasting revenue
 - product/customer attributes
 - distribution channels
 - adoption rates
 - technology
 - may be public or private
 - IPO prospectuses contain data on recently-private/newly-public ventures
 - other data sources

Forecasting Revenue of a New Venture: Fundamental Analysis



- Fundamental analysis
 - market size and market share
 - engineering cost estimates
 - demand-side approach
 - supply-side approach
 - credibility and support for assumptions
 - mixed approach

Yardsticks: A Simple Example



- Entrepreneur is considering launching a coffee shop, Morebucks, and collects the following data:

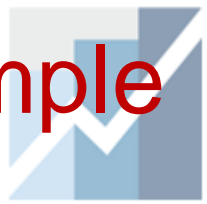
<i>Company</i>	<i>Year</i>	<i>No. of shops owned</i>	<i>Revenue (\$million)</i>	<i>Revenue/shop (\$)</i>
Coffee People, Inc. ^a	1997	31	27.7 ^a	893,500
Diedrich Coffee, Inc.	2008	5	4.4	880,000
Peet's Coffee & Tea, Inc.	2008	188	187.7	998,400
Starbucks, Inc.	2008	7,238 ^b	6,997.7 ^b	966,800

^aCoffee People, Inc. revenue adjusted to 2008 dollars using an inflation rate of 3 percent per year.

^bData are for US company-operated stores. All Peet's retail stores in the United States are company operated.

Revenue?

Fundamental Analysis: A Simple Example

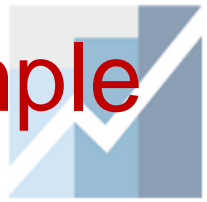


- Morebucks entrepreneur researches two coffee shop locations and assembles the following data:

<i>Comparable type</i>	<i>Days per year</i>	<i>Hours per day</i>	<i>Customers per hour</i>	<i>Revenue per customer</i>	<i>Annual revenue</i>
Business/entertainment center	360	18	25	\$6.00	\$972,000
Business only	300	12	30	\$4.50	\$486,000

- direct observation
- communication with
 - other coffee shop owners
 - real estate professionals
 - trade associations

Yardsticks: A More Challenging Example



- New venture will integrate GPS, street maps, topographical data, and real-time air traffic information into a navigation system for general aviation
- No single comparable, but the following yardsticks have some similar dimensions
 - Navteq Corporation
 - Garmin Ltd.
 - GPS Industries, Inc.
- Information from these yardsticks can be used to synthesize a revenue forecast for the new venture

Table 1

Aviation Navigation Yardstick Companies

Navteq Corporation

a leading developer and provider of a navigable database for use in route guidance products in the US and Europe

Founded	1987
IPO	1996
Acquired by Nokia	2007

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total Revenue (\$000s)	1,855	2,486	3,673	5,268	8,678	26,844	51,088	82,195	110,431	165,849
Percent Growth		34.0%	47.7%	43.4%	64.7%	209.3%	90.3%	60.9%	34.4%	50.2%

Garmin Ltd.

a leading provider of navigation communications and information devices using GPS

Founded	1989
IPO	2000

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total Revenue (\$000s)	102,474	135,874	160,280	169,030	232,586	230,183	263,358	350,647	572,989	762,549
Percent Growth		32.6%	18.0%	5.5%	37.6%	-1.0%	14.4%	33.1%	63.4%	33.1%
Avionics Revenue (\$000s)			38,255	33,584	63,422	115,558	105,761	114,470	120,552	171,526
Percent Growth				-12.2%	88.8%	82.2%	-8.5%	8.2%	5.3%	42.3%

GPS Industries, Inc.

GPS and Wi-Fi multimedia solutions for golf facilities

Founded	1999
Reverse merger	2000

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Revenue (\$000s)	0	0	0	0	0	2,184	5,818	6,576	7,266	13,490
Percent Growth							166.4%	13.0%	10.5%	85.7%

Fundamental Analysis: A More Challenging Example



- General aviation navigation system
- Data collected from the General Aviation Manufacturers Association (GAMA)
 - two segments: OEM and retrofit
 - historical data on sales growth rates
 - aircraft type and rate of adoption
- Selling price of \$2,500

Table 2

Fundamental Analysis of General Aviation Market and Revenue Forecast



Panel (a) — General Aviation New Airplane Shipments by Type Mfd. in the US

Year	Total New	Fixed Wing					Estimate OEM Market*	Growth
		Piston Single	Multi-Engine	Turbo Prop	Jet	Rotocraft		
2004	2,952	1,706	52	194	403	597	1,933	
2005	3,619	2,024	71	240	522	762	2,311	19.56%
2006	4,007	2,208	79	256	604	860	2,525	9.26%
2007	4,384	2,097	77	290	815	1,105	2,489	-1.43%
2008	4,367	1,700	91	333	955	1,288	2,155	-13.42%
*Est. OEM Market = all Piston Single + 40% of Turboprop + 25% of rotocraft							Avg. Growth	3.49%

Panel (b) — US General Aviation Aircraft Fleet by Type and Year

Year	Total Fleet	Fixed Wing					Total US Estimate Retrofit Mkt*
		Piston Single	Multi-Engine	Turbo Prop	Jet	Rotocraft	
2004	190,580	146,613	18,469	8,379	9,298	7,821	151,920
2005	194,006	148,101	19,412	7,942	9,823	8,728	153,460
2006	191,345	145,036	18,708	8,063	10,379	9,159	150,551
2007	192,007	144,580	18,555	8,190	10,997	9,685	150,277
Forecast							
2008	193,120	144,220	18,385	8,300	12,000	10,215	150,094
2009	194,495	144,030	18,225	8,425	13,055	10,760	150,090
2010	196,155	144,015	18,055	8,565	14,220	11,300	150,266
2011	197,935	144,115	17,895	8,710	15,410	11,805	150,550
2012	199,765	144,325	17,725	8,855	16,590	12,270	150,935
2013	201,670	144,645	17,565	9,005	17,740	12,715	151,426
2014	203,595	145,075	17,410	9,155	18,805	13,150	152,025
2015	205,565	145,620	17,245	9,310	19,845	13,545	152,730
Forecast period CAGR:		0.14%	-0.91%	1.65%	7.45%	4.11%	0.25%
*Est. Retrofit Market = all Piston Single + 40% of Turboprop + 25% of rotocraft							

Panel (c) — Unit Sales and Revenue Forecast (\$000)

Year	Est. OEM Market	Est. Mkt. Share	Est. OEM Sales	Est. Retro. Market	Est. Mkt. Share	Est. Retro. Sales	Total Units	Est. Revenue
2010	2,308	3%	58	150,266	1.0%	1,503	1,560	\$ 3,901
2011	2,389	5%	119	150,550	2.0%	3,011	3,130	\$ 7,826
2012	2,472	10%	247	150,935	3.0%	4,528	4,775	\$ 11,938
2013	2,559	15%	384	151,426	2.0%	3,029	3,412	\$ 8,531
2014	2,648	20%	530	152,025	1.0%	1,520	2,050	\$ 5,125
2015	2,740	20%	548	152,730	1.0%	1,527	2,075	\$ 5,188

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2013	201,670	144,645	17,565	9,005	17,740	12,715	151,426		
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Forecast period CAGR:		0.14%	-0.91%	1.65%	7.45%	4.11%	0.25%		

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Fundamental Analysis of General Aviation Market and Revenue Forecast

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Forecasting Revenue of a New Venture: Fundamental Analysis



- Fundamental analysis
 - market size and market share
 - engineering cost estimates
 - demand-side approach
 - supply-side approach
 - credibility and support for assumptions
 - mixed approach



Demand and Supply Considerations

- Demand-side approach
 - assesses consumer willingness and ability to buy the product, assuming that the venture has adequate capacity to supply all of the demand
- Supply-side approach
 - seeks to determine how fast the venture can grow given managerial, financial, and other resource constraints

Demand and Supply Considerations



- Demand-side considerations
 - What geographic market will the venture serve?
 - How many potential customers are in the market?
 - How rapidly is the market growing?
 - How much, in terms of quantity, is a typical customer likely to purchase during a forecast period?
 - How are purchase amounts likely to change in the future?
 - What is the expected average price of the venture's product?

Demand and Supply Considerations



- Demand-side considerations (cont'd.)
 - How good is the venture's product compared to competitors' products?
 - How aggressively and effectively, compared to competitors, will the venture promote its product?
 - How are competitors likely to react to the venture?
 - Who are potential market entrants, and how likely are they to enter?
 - In light of the above, what market share is the venture likely to be able to achieve?

Demand and Supply Considerations



- Supply-side considerations
 - Given its existing resources, how much can the venture produce, market, and distribute?
 - How rapidly can the venture add and integrate the resources needed for expansion of output?



Estimating Uncertainty

- Assessing risk using historical data
- Sensitivity analysis
- Developing alternative scenarios
- Incorporating uncertainty with simulation



Estimating Uncertainty

- Assessing risk using historical data

<i>Year</i>	<i>-5</i>	<i>-4</i>	<i>-3</i>	<i>-2</i>	<i>-1</i>
Sales growth	+20.0%	+12.5%	-3.7%	0.0%	+11.5%
Expected sales growth	+8.06%	+8.06%	+8.06%	+8.06%	+8.06%
Deviation from expected	+11.94%	+4.44%	-11.76%	-8.06%	+3.44%

- Forecast for Year 0
 - $\mu = 8.06\%$
 - $\sigma = 9.71\%$
- Difficult to estimate for new ventures



Estimating Uncertainty

- Sensitivity analysis
 - vary model assumptions and see the impact on the forecast
 - shortcomings
 - developing estimates for uncertainty of assumptions
 - ignores interdependencies among variables
- Developing alternative scenarios
 - allows several assumptions to vary at the same time and can incorporate correlations
 - data required to develop scenarios are available for many ventures
 - for some ventures, only a small number of realistic scenarios are possible



Estimating Uncertainty

- Incorporating uncertainty with simulation
 - assign probability distributions to key variables
 - estimate correlations among variables
 - based on historical data, yardsticks, or fundamental analysis

Building a New Venture Revenue Forecast



- NewCompany is a medical device start-up

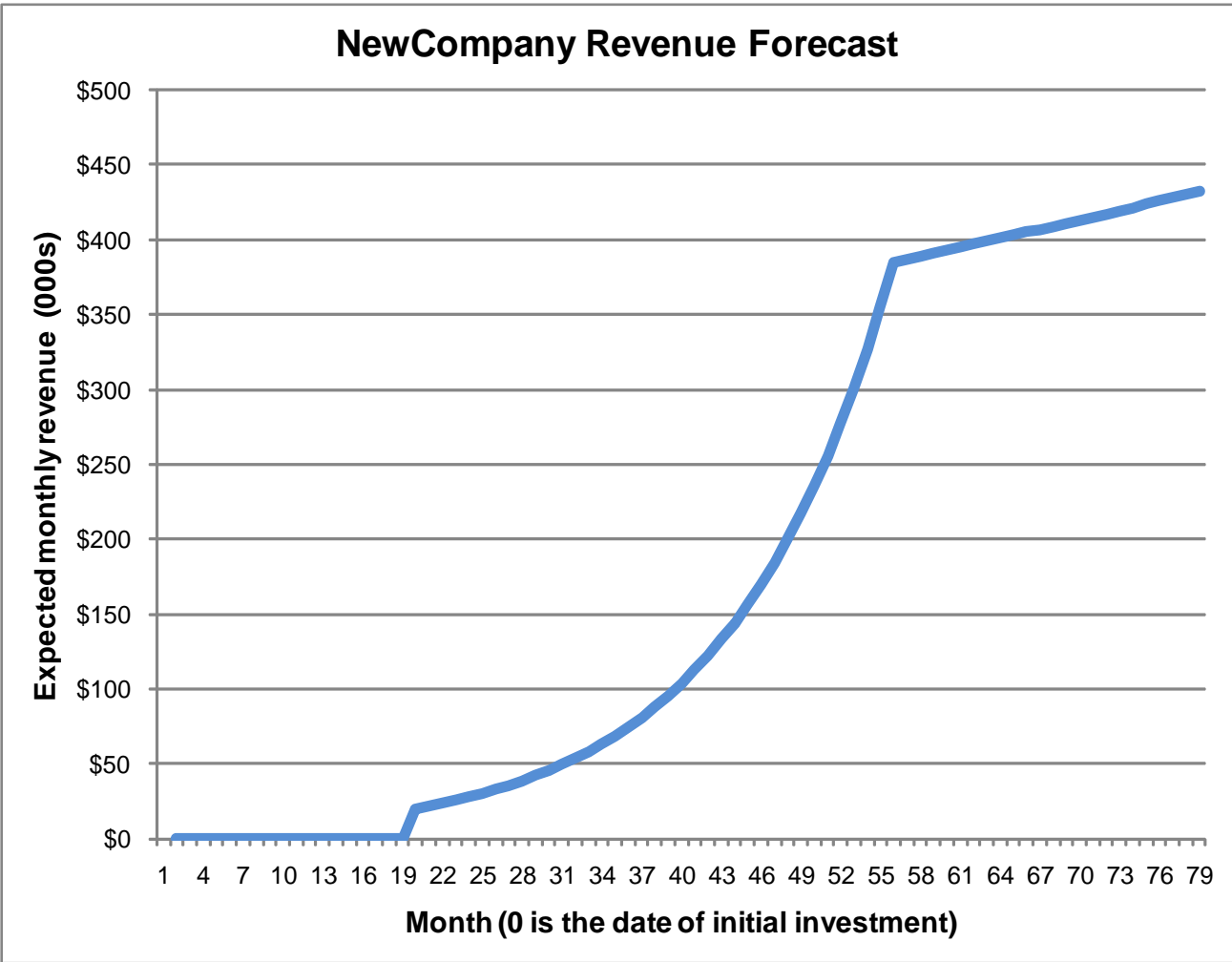
Figure 1 NewCompany revenue assumptions

1. Development will require 18 months, during which period no sales will be made.
2. Initial monthly sales of 100 units at a price of \$200 beginning in Month 19.
3. Unit sales will grow 8 percent per month for three years and then remain constant.
4. The sales price will increase each month at the inflation rate.
5. Inflation at 6 percent per year (modeled as 0.5 percent per month).

Figure 2

NewCompany - Revenue Forecast

Month	0	1	18	19	24	36	48	54	55	56	60	72	78
Sales (units)				100	147	373	940	1,491	1,610	1,610	1,610	1,610	1,610
Selling Price/unit				\$200.00	\$205.05	\$217.70	\$231.12	\$238.15	\$239.34	\$240.53	\$245.38	\$260.51	\$268.43
Revenue	\$0	\$0	\$20,000	\$30,142	\$81,201	\$217,257	\$355,075	\$385,331	\$387,258	\$395,061	\$419,428	\$432,169	
Unit Growth per Month					8.00%	8.00%	8.00%	8.00%	8.00%	0.00%	0.00%	0.00%	0.00%
Inflation per Month					0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%





Introducing Uncertainty to the Forecast

- Figure 2 is the forecast of *expected* sales
- Range of outcomes is complete failure to phenomenal success
- Uncertainty about
 - product development
 - demand
 - growth
 - competition
- Impact on financing need and value

Introducing Uncertainty to the Forecast: Sensitivity Analysis



- Variation in monthly inflation
- Estimates from historical data and/or forecasts
- Impact on revenue

<i>Inflation scenario</i>	<i>Annual inflation</i>	<i>Monthly inflation</i>	<i>Revenue</i>		
			<i>Month 78</i>	<i>Average/month</i>	<i>Cumulative</i>
Low	3%	0.25%	\$373,000	\$212,000	\$12,717,000
Expected	6%	0.50%	\$432,000	\$235,000	\$14,074,000
High	9%	0.75%	\$500,000	\$260,000	\$15,588,000

Introducing Uncertainty to the Forecast: Sensitivity Analysis



- Variation in monthly sales growth

<i>Growth scenario</i>	<i>Unit growth (monthly)</i>	<i>Units</i>			<i>Cumulative revenue</i>
		<i>Month 78</i>	<i>Average/month</i>	<i>Cumulative</i>	
Low	4%	406	291	17,438	\$4,187,000
Expected	8%	1,610	958	57,498	\$13,074,000
High	12%	5,936	3,185	191,070	\$47,277,000

Introducing Uncertainty to the Forecast: Sensitivity Analysis



- Variation in inflation and sales growth

Cumulative revenue over forecast period

		<i>Monthly growth in unit sales</i>		
		<i>Low (4%)</i>	<i>Expected (8%)</i>	<i>High (12%)</i>
<i>Monthly inflation</i>				
Low	0.25%	\$3,857,000	\$12,614,000	\$42,338,000
Expected	0.50%	\$4,229,000	\$13,960,000	\$47,104,000
High	0.75%	\$4,642,000	\$15,462,000	\$52,432,000

- little guidance for assumption ranges
- difficult to assess more than two variables
- does not accommodate correlation of variables

Introducing Uncertainty to the Forecast: Scenario Analysis



- Can include more variables and incorporate interdependencies

NewCompany Scenario 1

Product development proceeds more quickly than expected. The venture's sales start at 100 units in Month 12 rather than Month 19. The new product does very well in the market and NewCompany is able to patent important aspects of the technology. This keeps competitors at bay, and allows NewCompany to increase the initial selling price to \$220. Unit sales grow at 11 percent each month for two years and then 9 percent monthly for one year. For the balance of the forecast period, Month 49 to Month 78, monthly unit sales are assumed constant so that revenue grows at the 0.5 percent inflation rate.

Introducing Uncertainty to the Forecast: Scenario Analysis



NewCompany Scenario 2

Product development hits numerous roadblocks and a competitor beats NewCompany to the market. When NewCompany finally begins to sell (in Month 24), the market only supports a \$180 price. Unit sales start at 100 and grow at 4 percent each month for two years and then 2 percent for one year before falling to zero. Expected inflation is 0.5 percent per month.

Introducing Uncertainty to the Forecast: Scenario Analysis



Impact of NewCompany Scenarios on Revenue Forecast

	<i>Revenue</i>			<i>Unit sales</i>		
	<i>Month 78</i>	<i>Monthly average</i>	<i>Cumulative</i>	<i>Month 78</i>	<i>Monthly average</i>	<i>Cumulative</i>
Scenario 1	\$1,231,301	\$693,069	\$41,584,139	4,027	2,501	150,062
Scenario 2	\$75,639	\$47,189	\$2,831,359	321	243	13,379

- These scenarios provide a rough picture of the uncertainty about the venture's future

Introducing Uncertainty to the Forecast: Simulation



Figure 3

NewCompany revenue simulation assumptions

1. The earliest that successful development can occur is Month 8. After Month 8, the probability of development success is exponentially distributed with a mean of 18 months (26 months including the first 8). However, if development is not completed within 48 months, then it is clear that successful development of a valuable product is no longer feasible.
2. If development is successful, the rapid-growth stage is expected to end around Month 60, after which it is expected that unit sales growth will fall to zero. The uncertainty about when the rapid-growth stage will end is normally distributed with a mean of 60 and standard deviation of three months.
3. Sales begin the month after development is successful. The initial sales level is expected to be 100 units.
4. The initial selling price is subject to uncertainty depending on the quality of the development result and competitive factors. This uncertainty is normally distributed with a mean of \$200 and a standard deviation of \$10. After the first month of sales, the selling price increases at the rate of inflation each month.
5. During the rapid-growth period, monthly unit sales growth is normally distributed with a mean of 8 percent and a standard deviation of 1.5 percent.
6. Inflation is forecast to be 0.50 percent per month.

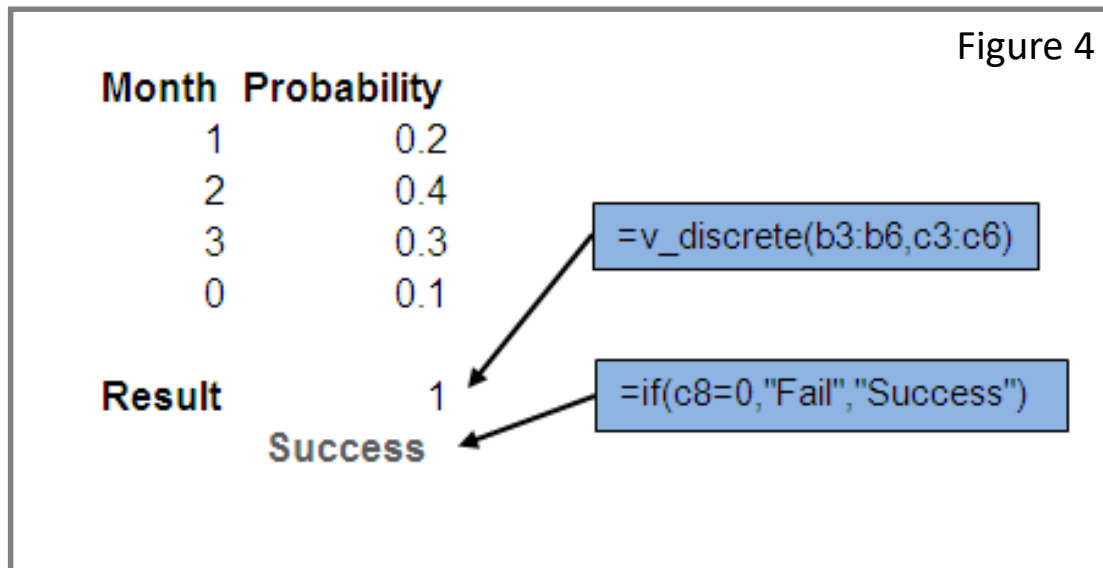
Introducing Uncertainty to the Forecast: Simulation



- Simulating development timing example

Month	1	2	3
Probability of success	20%	40%	30%

- 10% chance of development failure
- Using *Venture.SIM*



Introducing Uncertainty to the Forecast: Simulation



- Development timing for NewCompany
 - earliest success is Month 8
 - probability increases after Month 8 and then tapers off
 - by Month 48 probability of successful development is 90%
 - after Month 48, development is assumed to fail (=Month 79)
 - estimated using an exponential distribution
 - *Venture.SIM* formula is
= INT(V_Exp(18) + 8)

Figure 5



Unconditional Simulation Results

Trials = 10000

Output

	<i>Average</i>	<i>Median</i>	<i>Standard Deviation</i>	<i>Skewness</i>
1 Development Success	26.58	20.00	20.09	1.63

Percentiles				
<i>Minimum</i>	<i>25%</i>	<i>50%</i>	<i>75%</i>	<i>Maximum</i>
8.00	13.00	20.00	32.00	79.00



Introducing Uncertainty to the Forecast: Simulation



- NewCompany simulation assumptions
 - development month is estimated using an exponential distribution: *Venture.SIM* formula is = INT(V_Exp(18) + 8)
 - end of rapid-growth period
 - Normal: $\mu = \text{Month } 60$ $\sigma = 3 \text{ months}$
 - monthly sales growth rapid-growth period:
 - Normal: $\mu = 8\%$ $\sigma = 1.5\%$
 - Initial selling price:
 - Normal: $\mu = \$200$ $\sigma = \$10$

Figure 6 NewCompany revenue forecast—sample trial results

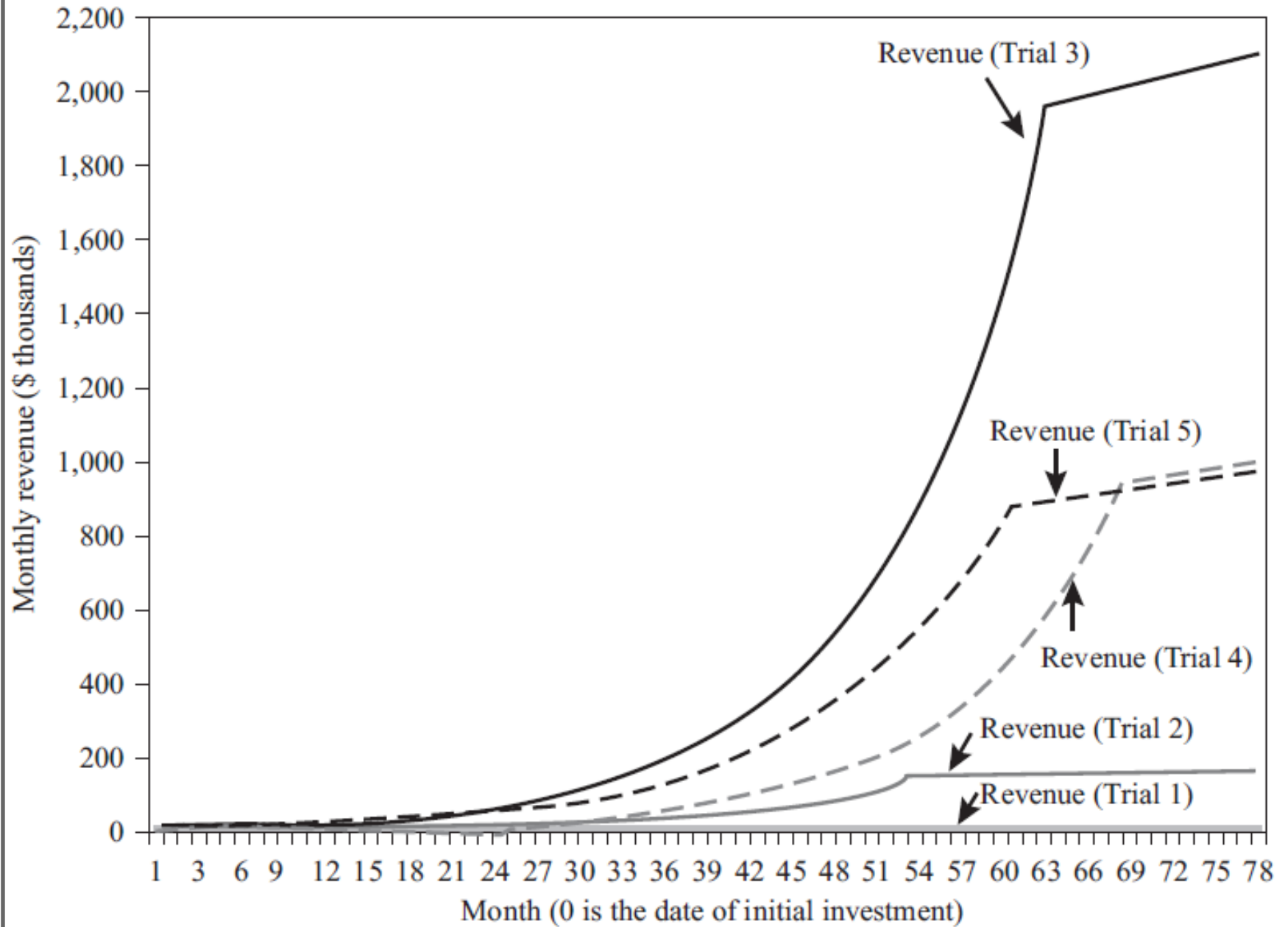
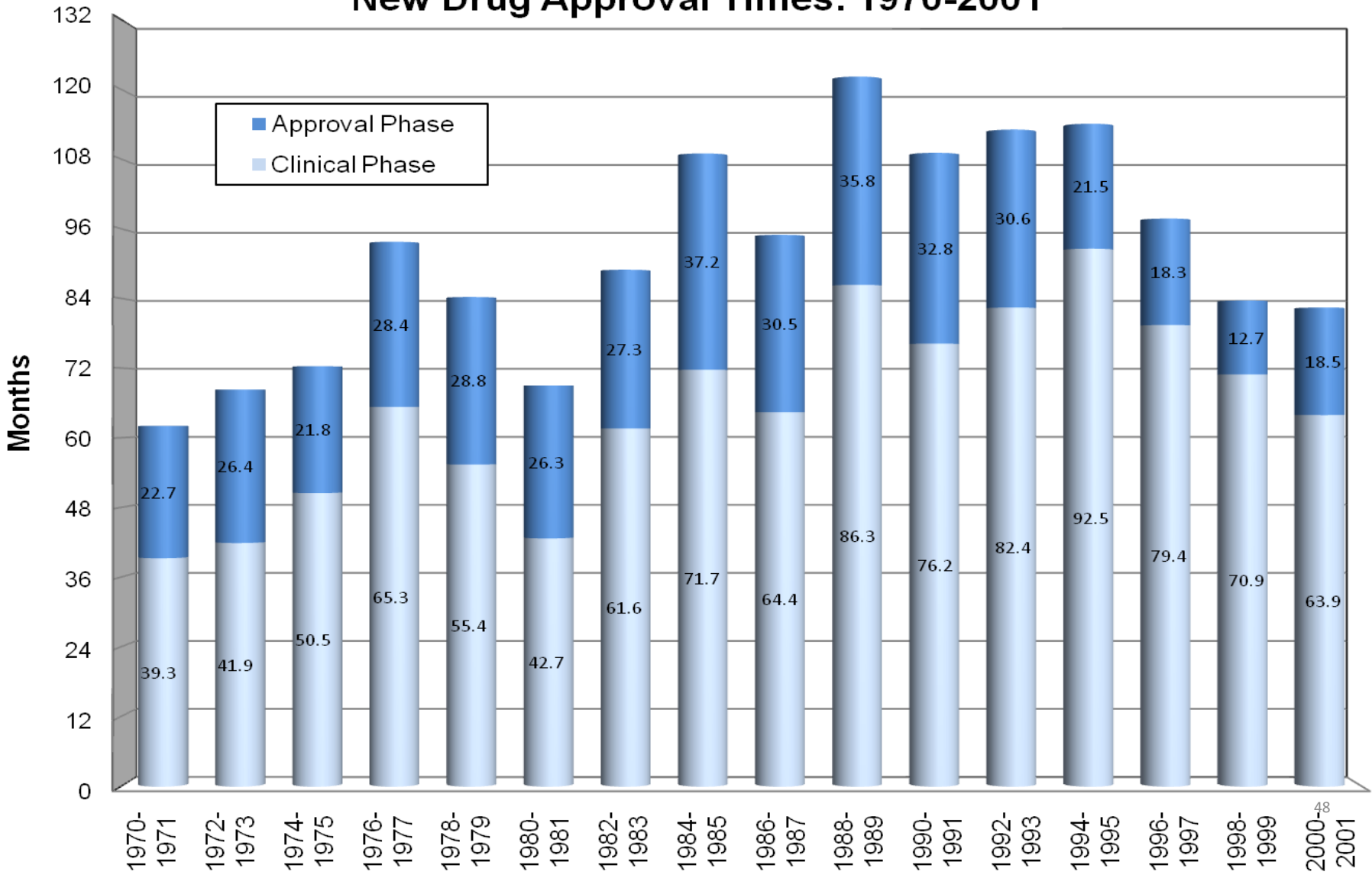


Figure 7



Development Timing: An Example

New Drug Approval Times: 1970-2001



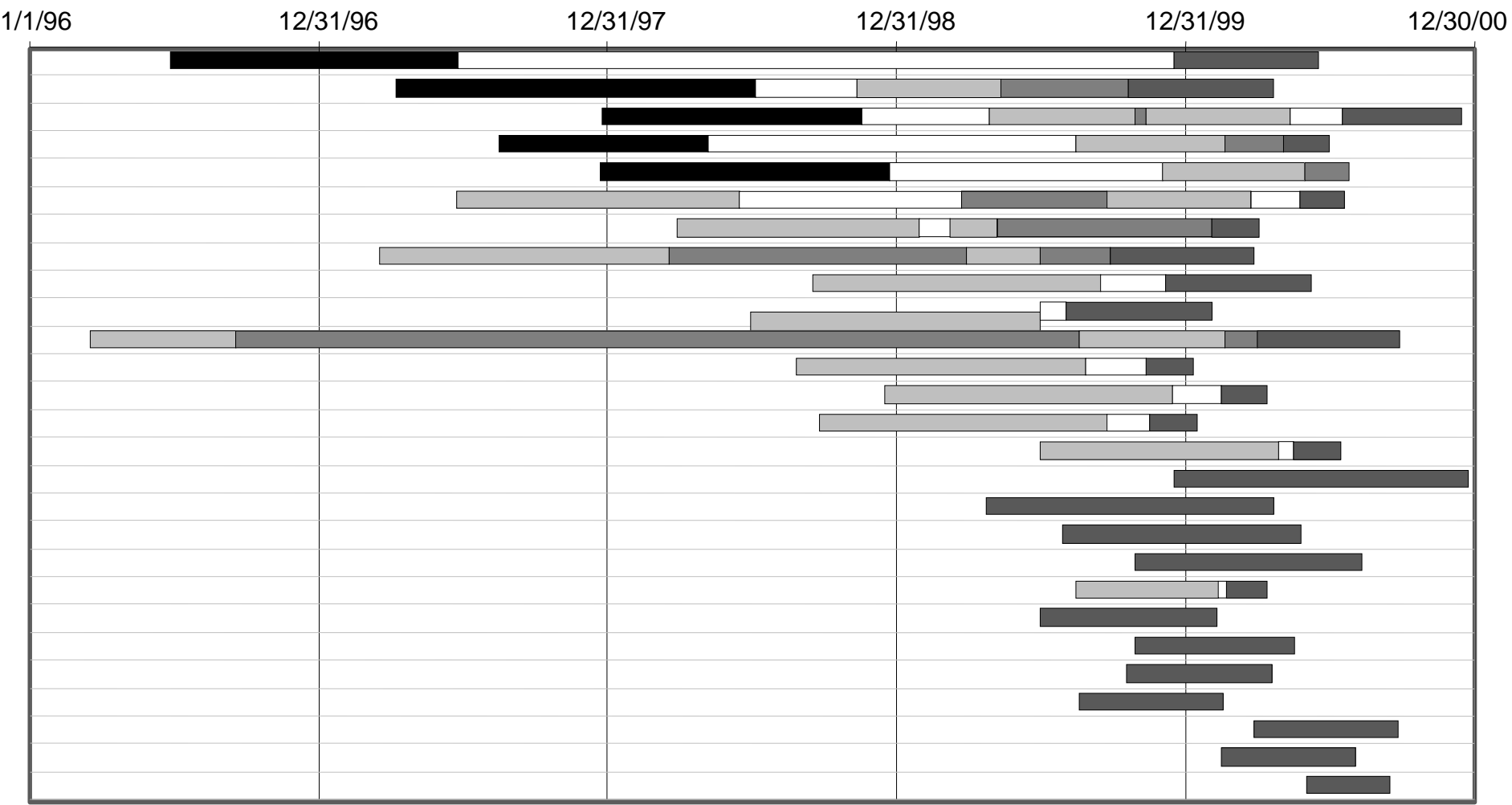
⁴⁸

Figure 8



Development Timing: An Example

New drug approval times in 2000





Methods of Financial Forecasting – Revenue: Summary

- Methods of forecasting revenue for an established business
- Forecasting new venture revenue
 - yardsticks and fundamental analysis
- Demand and supply considerations
- Introducing uncertainty
 - sensitivity analysis
 - developing scenarios
 - simulation

Reference and source



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