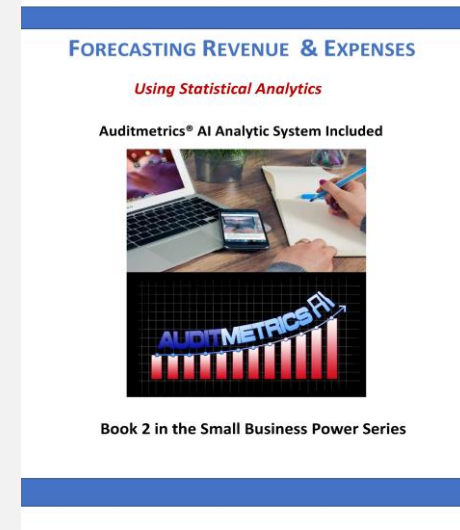


Microsoft Certified Software

Business & AI Partners:

- *AUDITMETRICS® AI-SYSTEMS*  
JOSEPH BOFFA
- *SPRINGER® PUBLISHING*



# Different AI Scenarios

With References From

AI Assisted Business Analytics  
Techniques for Reshaping Competitiveness\*

For the best use of your time, download the free version of Auditmetrics v6.5 and GettingStarted.pdf with its link to practice data files. [Auditmetrics AI](#)

\* Springer Book references are on the slide upper left corner

***Both books are designed for enhancing intermediate and advance courses in financial administration or used as books for tutorials and student projects***

# AI Analytics

## Build a Database for Forecasting and Expanding Statistical Analytics

The cashflow case study 1: Managing Cashflow on Springer page 13 compares the operating cashflow budget with the income statement. It indicates cashflow being considerably lower than income. The main cause was a failure of managing accounts receivable. The solution was to conduct an internal statistical audit of the annual sales account. The auditor determined whether each transaction followed well-defined A/R procedures. Ultimately problems were defined and cashflow improved.

To take full advantage of the full potential of AI analytics including forecasting and market research, it was decided to audit 2 ½ years of revenue following the same auditing process as was for the periodic audit to improve cashflow. Auditmetrics AI v6.5 was used to select a random sample for analysis. The auditor decided to use a precision of .07 though the gold standard is .03. The auditor wanted to have a smaller sample size as a preliminary look at account data. A .07 precision will generate a sample size approximately 40% smaller than .03 precision.

# Getting Started with Auditmetrics®

*Detail Stratum does not rely on a sample but a review of 100% of the transactions. This removes high dollar volume transaction with the greatest economic impact from statistical error.*

Auditmetrics AI 6.5 Learning Version

for help: [info@Auditmetrics.com](mailto:info@Auditmetrics.com)

Detail

No. Strata

Precision   
(Margin of Error)

Efficiency

Total Sample

Sample Size Excel File

Sample Validation Excel File

Potential Detail Cutoffs

1. Sample Size Calculations

There are only three required inputs by the user.

Auditmetrics does the heavy lifting in the AI Assisted background.

Auditmetrics will analyze account data and provide feedback about options to meet AICPA standards. Excel sample and reports are generated to conduct Audit and provide documentation.

# Revenue Account to be Sampled

- N= 21,656 Required Auditmetrics Variables are Red \*

<b>Transaction_ID</b>	VENDOR_NUMBER	<b>amount</b>	<b>absamt</b>	TxDate	ACCOUNT	<b>DataSet</b>	ZipCode	CustomerID
6214	506	\$5.00	\$5.00	3/1/2020	5060	Acme Inc.	20134	15060
1154	555	\$5.00	\$5.00	2/1/2020	5050	Acme Inc.	20136	15550
2435	555	\$5.00	\$5.00	1/1/2021	5050	Acme Inc.	20134	15550
4054	555	\$5.00	\$5.00	4/1/2019	5060	Acme Inc.	20135	15550
7933	555	\$5.00	\$5.00	11/1/2020	5060	Acme Inc.	20137	15550
7941	555	\$5.00	\$5.00	11/1/2020	5060	Acme Inc.	20136	15550
7942	555	\$5.00	\$5.00	11/1/2020	5060	Acme Inc.	20136	15550
9904	555	\$5.00	\$5.00	5/1/2021	5060	Acme Inc.	20134	15550
20713	570	\$5.00	\$5.00	9/1/2020	6245	Acme Inc.	20137	15700
"	"	"	"	"	"	"	"	"

\*Software & Getting Started.PDF: [AuditmetricsAI.com](https://www.auditmetrics.com/AuditmetricsAI.com)

Getting Started.PDF has the dataset used in this exercise

**Sample Size Inputs**->Precision = .07, #Strata = 5, Detail Cutoff=1600 – inputs to calculate sample size n = 721

# AI has in the Background Tested Random Sample as OK

Total Sample

Potential Detail Cutoffs

- Sample Size Excel File
- Sample Validation Excel File

1. Sample Size Calculations

**Precision can vary from 3% to 10% with 3% being the gold standard. It would require a sample size much larger than with 7% for this exercise. A 3% sample size would be 1158 as compared to 721.**

- Select Another Audit Population?

Population:

N	Mean	Total \$
10101	19.02	192150.03
5776	91.67	529492.47
2813	258.69	727690.32
1614	548.66	885532.28
888	1106.04	982160.59
463	1880.24	870548.95


Sample Summary:  
Validation Tests Listed Below

n	Mean	SD.	Total \$		
47	18.72	13.48	880	ok	ok
49	91.95	34.35	4506	ok	ok
52	243.26	115.06	12649	ok	ok
54	556.36	120.4	30043	ok	ok
56	1141.6	234.2	63930	ok	ok
463	1880.24	632.25	870549		

Validation #1- Observed precision under 0.07 no need to resample

Validation #2- Strata specific test passed.

## AI Software Generated Excel Summary With All Strata Passing 95% Confidence Interval Test

Acme Inc.									
	Population			Sample			Strata Validity Test		
Strata	Pop. Mean	Pop.Total Value	Pop. Freq.	Sample Mean	Sample Total Value	Sample Size	Lower 5% Alpha Bound	Upper 5% Alpha Bound	
<b>0 -49.99</b>	\$19.02	\$192,150	10,101	\$18.74	\$881	47	13.31	\$24.16	<a href="#">pass</a>
<b>50-174.99</b>	\$91.67	\$529,492	5,776	\$91.66	\$4,491	49	75.32	\$108.00	<a href="#">pass</a>
<b>175-399.99</b>	\$258.69	\$727,690	2,813	\$276.94	\$14,401	52	257.31	\$296.56	<a href="#">pass</a>
<b>400-824.99</b>	\$548.66	\$885,532	1,614	\$560.72	\$30,279	54	504.04	\$617.40	<a href="#">pass</a>
<b>825-1600</b>	\$1,106.04	\$982,161	888	\$1,139.65	\$63,821	56	1,017.31	\$1,262.00	<a href="#">pass</a>
<b>&gt; 1600</b>	\$1,880.24	\$870,549	463	\$1,880.24	\$870,549	463			
<b>Total (Excluding Detail)</b>		<b>\$3,317,026</b>			<b>\$113,872</b>	<b>258</b>			
<b>Total (Including Detail)</b>		<b>\$4,187,575</b>			<b>\$984,421</b>	<b>721</b>			



# Scenario 1 - Strata Not Pass 95% Confidence Interval Test

Total Sample

721

Potential Detail Cutoffs

- Sample Size Excel File
- Sample Validation Excel File

1. Sample Size Calculations

**A 95% Confidence Interval test is conducted for each stratum, Comparing sample mean with actual total account mean. If one stratum fails, resample.**

- Select Another Audit Population?

## Population:

N	Mean	Total \$
10101	19.02	192150.03
5776	91.67	529492.47
2813	258.69	727690.32
1614	548.66	885532.28
888	1106.04	982160.59
463	1880.24	870548.95

## Sample Summary:

### Validation Tests Listed Below

n	Mean	SD.	Total \$		
47	22.55	13.46	1060	ok	ok
49	100.2	42.8	4910	ok	ok
52	282.79	65.25	14705	*	ok
54	535.37	273.64	28910	ok	ok
56	1115.29	516.02	62456	ok	ok
463	1880.24	632.25	870549		

Validation #1- Observed precision under 0.07 no need to resample

Validation #2- Strata specific test not passed, resample.

# AI Generated Excel Documentation of Failed Test

	A	B	C	D	E	F	G	H	J	K	L	
1	Acme Inc.											
2		Population			Sample				Strata Validity Test			
3	Strata	Pop. Mean	Pop.Total Value	Pop. Freq.	Sample Mean	Sample Std. Dev.	Sample Total Value	Sample Size	Lower 5% Alpha Bound	Upper 5% Alpha Bound		
4												
5	0-49.99	\$19.02	\$192,150	10,101	\$22.55	\$13.46	\$1,060	47	18.70	\$26.40	pass	
6	50-174.99	Acct.	\$91.67	\$529,492	5,776	\$100.20	\$42.80	\$4,910	49	88.22	\$112.18	pass
7	175-399.99	actual mean	<b>\$258.69</b>	\$727,690	2,813	\$282.79	\$65.25	\$14,705	52	<b>265.06</b>	<b>\$300.53</b>	fail
8	400-824.99	outside 95% CI	\$548.66	\$885,532	1,614	\$535.37	\$273.64	\$28,910	54	462.38	\$608.35	pass
9	825-1600		\$1,106.04	\$982,161	888	\$1,115.29	\$516.02	\$62,456	56	980.14	\$1,250.44	pass
10	> 1600		\$1,880.24	\$870,549	463	\$1,880.24	\$632.25	\$870,549	463			
11	<b>Total (Excluding Detail)</b>		<b>\$3,317,026</b>				<b>\$112,041</b>	<b>258</b>				
12	Total (Including Detail)		\$4,187,575				\$982,590	721				



# Scenario 2 -Sample Does not Meet Precision Standard

This sample can be termed an “Outlier”

Total Sample

721

Potential Detail Cutoffs

Sample Size Excel File

Sample Validation Excel File

1. Sample Size Calculations

AI is indicating sample estimated account total is not equal or less than the precision of .07 used in designing the random sample. Solution is to select another sample.

Population:

N	Mean	Total \$
10101	19.02	192150.03
5776	91.67	529492.47
2813	258.69	727690.32
1614	548.66	885532.28
888	1106.04	982160.59
463	1880.24	870548.95

Sample Summary:

Validation Tests Listed Below

n	Mean	SD.	Total \$
47	24.91	15.93	1171
49	103.75	53.23	5084
52	293.53	67.6	15264 *
54	557.32	278.06	30095 *
56	1193.72	375.97	66848
463	1880.24	632.25	870549

Validation #1- Precision exceeds 0.07 need to resample

# Mean per Unit Estimate Technique in Testing for Accepted Precision

Acme Inc.											Mean Per Unit Estimate of Total MPU
Strata	Population			Sample				Strata Validity Test		N $\bar{X}$	
	Pop. Mean	Pop.Total Value	Pop. Freq. N	Sample Mean $\bar{X}$	Sample Std. Dev.	Sample Total Value	Sample Size	Lower 5% Alpha Bound	Upper 5% Alpha Bound		
0 -49.99	\$19.02	\$192,121	10,101	\$22.14	\$16.34	\$1,026	47	17.47	\$26.81	pass	223,636
50-174.99	\$91.67	\$529,486	5,776	\$98.11	\$48.60	\$5,000	49	84.50	\$111.72	pass	566,683
175-399.99	\$258.69	\$727,695	2,813	\$312.00	\$69.65	\$14,769	52	293.07	\$330.93	fail	877,656
400-824.99	\$548.66	\$885,537	1,614	\$595.79	\$125.31	\$32,173	54	562.37	\$629.22	fail	961,613
825-1600	\$1,106.04	\$982,164	888	\$1,163.81	\$392.38	\$65,173	56	1,061.04	\$1,266.58	pass	1,033,462
> 1600 (Detail)	\$1,880.24	\$870,549	463	\$1,880.24	\$632.25	\$870,549	463				
<b>Total (Excluding Detail)</b>		<b>\$3,317,003</b>				<b>\$118,141</b>	<b>258</b>				<b>3,663,051</b>
Total (Including Detail)		\$4,187,552				\$988,690	721				
<b>Precision Test Fails</b>											
Expected Total =	<b>\$3,317,003</b>	Expected Precision=	<b>7%</b>	Observed Total		<b>\$3,663,051</b>	Observed Precision=				<b>9.4%</b>

The Auditmetrics precision built into the original sample size calculation is that the account total projected from the sample will be within 7% of the actual account total. The sample size n= 721 is used to project account total using mean per unit projection. The precision test has failed. The projected account total exceeds the 7% standard. The solution is simple, draw another sample.

# AI Generated Excel (.csv) Random Sample n=721

	A	B	C	D	E	F	G	H	I	J	K
1	Count	Transaction_ID	VENDOR_NUMBER	amount	absamt	TxDate	ACCOUNT	DataSet	ZipCode	CustomerID	Strata
2	1	4227	555	\$5.76	\$5.76	4/1/2019	5060	Acme Inc.	20136	15550	1
3	2	8019	506	\$6.33	\$6.33	11/1/2020	5060	Acme Inc.	20134	15060	1
4	3	9814	506	\$6.66	\$6.66	5/1/2021	5060	Acme Inc.	20134	15060	1
5	4	16355	2698	\$7.16	\$7.16	3/1/2020	5860	Acme Inc.	20134	36980	1
6	5	12658	676	\$7.85	\$7.85	3/1/2020	5705	Acme Inc.	20135	16760	1
7	6	9489	506	\$8.33	\$8.33	4/1/2021	5060	Acme Inc.	20136	15060	1
8	7	9447	566	\$8.35	\$8.35	3/1/2021	5060	Acme Inc.	20136	15660	1
9	8	6164	566	\$8.59	\$8.59	3/1/2020	5060	Acme Inc.	20135	15660	1
10	9	22970	699	\$16.45	\$16.45	9/1/2020	6295	Acme Inc.	20134	16990	1
11	10	22311	524	\$8.85	\$8.85	3/1/2021	6245	Acme Inc.	20134	15240	1
12	"	"	"	"	"	"	"	"	"	"	"
715	714	24328	3028	\$2,400.00	\$2,400.00	8/1/2019	6838	Acme Inc.	20134	40280	6
716	715	11563	3118	\$2,400.00	\$2,400.00	4/1/2021	5530	Acme Inc.	20134	41180	6
717	716	23628	2380	\$2,403.32	\$2,403.32	5/1/2021	6650	Acme Inc.	20134	33800	6
718	717	17987	2078	\$2,406.15	\$2,406.15	5/1/2021	5860	Acme Inc.	20136	30780	6
719	718	25183	2894	\$2,415.00	\$2,415.00	11/1/2020	6850	Acme Inc.	20135	38940	6
720	719	25055	3941	\$2,415.00	\$2,415.00	6/1/2020	6850	Acme Inc.	20137	49410	6
721	720	15161	2333	\$2,420.00	\$2,420.00	8/1/2020	5835	Acme Inc.	20137	33330	6
722	721	3314	412	\$2,422.00	\$2,422.00	6/1/2021	5050	Acme Inc.	20137	14120	6





## Sample Audit Summary

	Sample		Audit Results		
Strata #	Sample Total Value	Sample Size	Amount Error	Error Ratio	Pop. Est. Error Amt.
Stratum 1	\$899	47	\$48.16	0.054	\$10,291.65
Stratum 2	\$4,277	49	\$151.48	0.035	\$18,752.82
Stratum 3	\$12,523	52	\$741.70	0.059	\$43,097.59
Stratum 4	\$28,716	54	\$1,880.36	0.065	\$57,985.23
Stratum 5	\$62,075	56	\$1,334.00	0.021	\$21,106.63
Aud 100	\$870,549	463	\$25,972.00	0.030	\$25,972.86



# Ratio Estimate of Account Item in Error for Stratum 1

	Population			Sample			Audit Results			
Strata	Pop. Mean	Pop.Total Value	Pop. Freq.	Sample Mean	Sample Total Value	Sample Size	Amount Error		Sample Error Ratio	Pop. Est. Error Am
<b>Ratio Method:</b>		<b>\$192,150</b>						<b>X</b>	<b>48.16/899 =</b>	<b>\$10,291.</b>
0 -49.99	\$19.02	\$192,150	10,101	\$19.13	\$899	47	\$48.16		0.054	\$10,292
50-174.99	\$91.67	\$529,492	5,776	\$87.29	\$4,277	49	\$151.48		0.035	\$18,753
175-399.99	\$258.69	\$727,690	2,813	\$240.83	\$12,523	52	\$741.70		0.059	\$43,098
"	"	"	"	"	"	"	"		"	"

# Total Audit Summary Report Using Ratio Method in Estimating Total Account Dollars in Error

Acme Inc.									
Population			Sample			Audit Results			
Strata	Pop. Mean	Pop.Total Value	Pop. Freq.	Sample Mean	Sample Total Value	Sample Size	Amount Error	Error Ratio	Pop. Est. Error Amt.
0 -49.99	\$19.02	\$192,150	10,101	\$19.13	\$899	47	\$48.16	0.054	\$10,291.65
50-174.99	\$91.67	\$529,492	5,776	\$87.29	\$4,277	49	151.48	0.035	\$18,752.82
175-399.99	\$258.69	\$727,690	2,813	\$240.83	\$12,523	52	741.7	0.059	\$43,097.59
400-824.99	\$548.66	\$885,532	1,614	\$531.78	\$28,716	54	1880.36	0.065	\$57,985.23
825-1600	\$1,106.04	\$982,161	888	\$1,108.49	\$62,075	56	\$1,334.00	0.021	\$21,106.63
> 1600	\$1,880.24	\$870,549	463	\$1,880.24	\$870,549	463	\$25,972.86	0.030	\$25,972.86
<b>Total (Excluding Detail)</b>		<b>\$3,317,026</b>			<b>\$108,491</b>	<b>258</b>			
Total (Including Detail)		\$4,187,575			\$979,040	721			
<b>Error (Excluding Detail)</b>		<b>Std. Error (\$)</b>	<b>\$43078</b>				<b>Sample Adj=</b>	<b>0.046</b>	
Error (Including Detail)							Overall Rate:	0.042	
	<b>Sample Estimated Error -&gt;</b>	-1 Std. Error	\$108,156	<b>Detail Error</b>	<b>\$25,973</b>	<b>This spreadsheet is generate by Auditmetrics and all calculations are fully displayed. They are Excel functions or direct calculations. This is done to augment the discussions in the Springer Book.</b>			
		<b>Mid-Point</b>	<b>\$151,234</b>						
		+1 Std. Error	\$194,312						
(c) www.auditmetrics.com info@auditmetrics.com									
WORK AREA:		Total Amount Due=			<b>\$177,207</b>				
		Error Rate=			4.2%				

# Key Monitoring Measure - Efficiency Factor

- Efficiency Factor is a measure of statistical efficiency developed by Auditmetrics.
- It compares a simple non- stratified random sample standard error with that of a stratified random sample.
- In this context the detail stratum is not sampled but reviewed at 100% which enhances sample prediction efficiency
- Standard error measures the efficiency, accuracy, and consistency of a sample estimate.
- In other words, it measures how precisely the sample statistic represents the population parameter

# Reduction in Standard Error by Sampling Method

	Variance $\sigma$	Standard Error	Efficiency Factor	
Simple non-stratified Random Sample	\$141,623	14.27	0%	
Stratified sample, no detail	19,726	5.33	62%	$=1-(5.33/14.27)$
Stratified Sample with detail	\$11,439	4.06	72%	$=1-(4.06/14.27)$

- Efficiency Factor was developed so that the accountant can manage statistical efficiency
- The AI assistance can lead to a sample that meets precision and validity standards
- There are a multitude of possible account distributions so the accountant can yet fine tune
- AI is baseline but the accountant is the ultimate decision maker

# Size of a Non-Stratified Sample

- Non-Stratified sample size formula:

$$n = (Z_{.05} \times \sigma / P)^2$$

where:

Z = 1.96 standard normal curve cutoff for 95% confidence interval

$\sigma$  = standard deviation = \$372

P (precision) = 3% × \$202 (acct. mean) = \$6.06

$$n = (1.96 \times \$372 / \$6.06)^2$$

$$n = 14,476 \text{ (20 x higher than the n for stratified random sample with detail)}$$

stratification enhances both statistical efficiency and economic efficiency



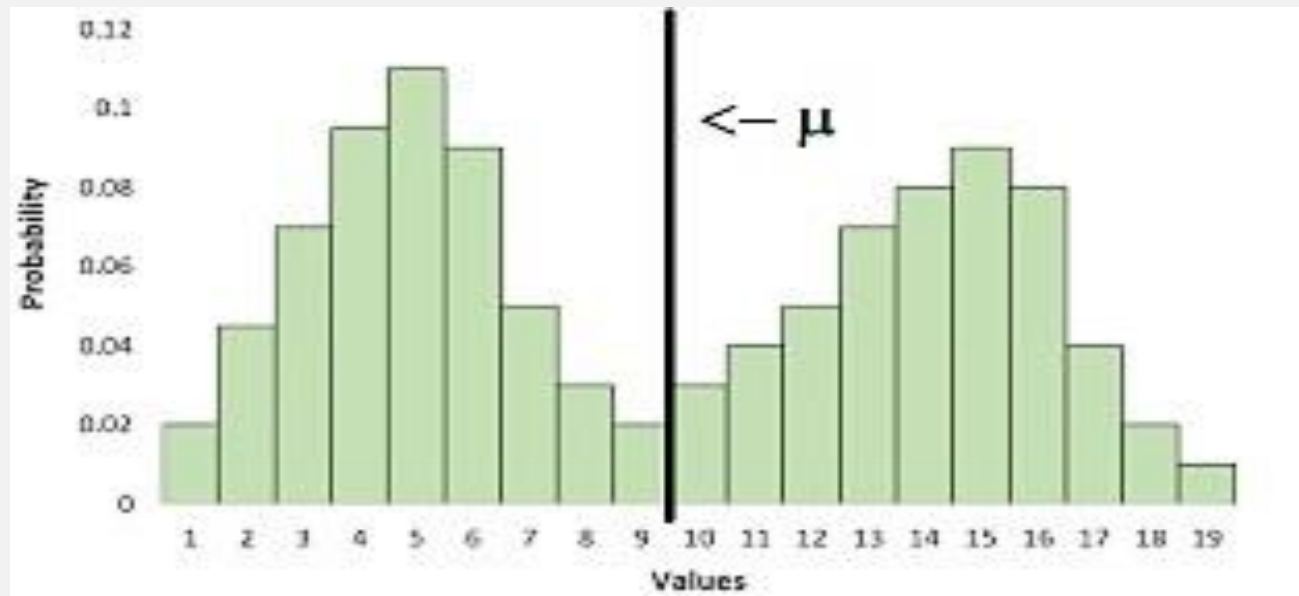
## Targeted Efficiency Factor

- There are some rules of thumb to follow in assessing statistical efficiency.
- An acceptable efficiency should be  $\geq .70$ .
- Efficiency between 70 and 60 usually indicates a highly skewed population. Testing different strata numbers and/or detail cutoffs may improve efficiency.
- Between .50 and .60, a plotting or histogram of the data may reveal a pattern of extreme scores that may help in refining the specifications of the audit population.
- In some instances auditors contacted us that they couldn't get an efficiency factor out of the 40% range.

# Bimodal Distribution

There was an auditor who could not obtain an efficiency factor greater than 45%. A plot revealed a bimodal distribution which meant that two separate independent accounts were arbitrarily pulled together.

The solution - audit each account separately



## Review of the Audit Process

- The steps of designing the sample size were all selected to enhance the precision of sample estimates:
  1. Determine outlier strata or detail for review at 100%
  2. Stratify remaining population for sample size calculation using 3% or higher precision and 95% confidence interval. With Auditmetrics 95% is built in.
  3. Target efficiency factor to be .70 or better is ideal, .60-70 would be ok. *Changing number of strata or detail cutoff can be of help in fine tuning efficiency.*
  4. If Built by Auditmetrics two validity checks of the selected sample are conducted.
    - Perform validity check #1 for each strata using 95% confidence interval
    - Assure precision when test #2 MPU reaches target account total

# Audit Results Summary

- After the preliminary audit the auditor found that there were still some cashflow problems to be solved.
- The auditor found 4.2% of the revenue transaction were lacking in terms of impeding cashflow.
- This audit was after previous accounts receivable audit
- The auditor encountered other issues:
  - Problems in bookkeeping regarding accounts payable and errors in payroll
  - Poor inventory control including poor timing of inventory in relation to seasonal fluctuations.
  - Excess Inventory during slow season results in tying up cash that can be better used elsewhere.
  - Insufficient inventory during busy season leading to delays in deliveries to customers or possible loss of customers.
- Once these issues are cleared up the decision is to do another random sampling for building a forecasting model but this time 3% precision

# Random Sample Reworked for Regression Modeling

*Using standard Excel Methods*

amount	absamt	TxDate	DataSet	Year	Month	Quarter	MonthCount	MonthTotal
-920	920	1/31/2019	Acme Inc.	2019	1	1	1	\$18,407
2107.99	2107.99	2/12/2019	Acme Inc.	2019	2	1	2	\$17,408
2000	2000	3/22/2019	Acme Inc.	2019	3	1	3	\$21,489
2047.9	2047.9	4/19/2019	Acme Inc.	2019	4	2	4	\$24,240
2045.04	2045.04	5/13/2019	Acme Inc.	2019	5	2	5	\$22,940
"	"	"	"	"	"	"	"	"
2400	2400	8/13/2019	Acme Inc.	2019	8	3	8	\$29,100
2302.84	2302.84	2/9/2021	Acme Inc.	2021	2	1	26	\$66,982
2381.32	2381.32	3/26/2021	Acme Inc.	2021	3	1	27	\$65,610
2250	2250	4/7/2021	Acme Inc.	2021	4	2	28	\$35,279
2403.32	2403.32	5/21/2021	Acme Inc.	2021	5	2	29	\$52,524
2229	2229	6/19/2021	Acme Inc.	2021	6	2	30	\$54,450

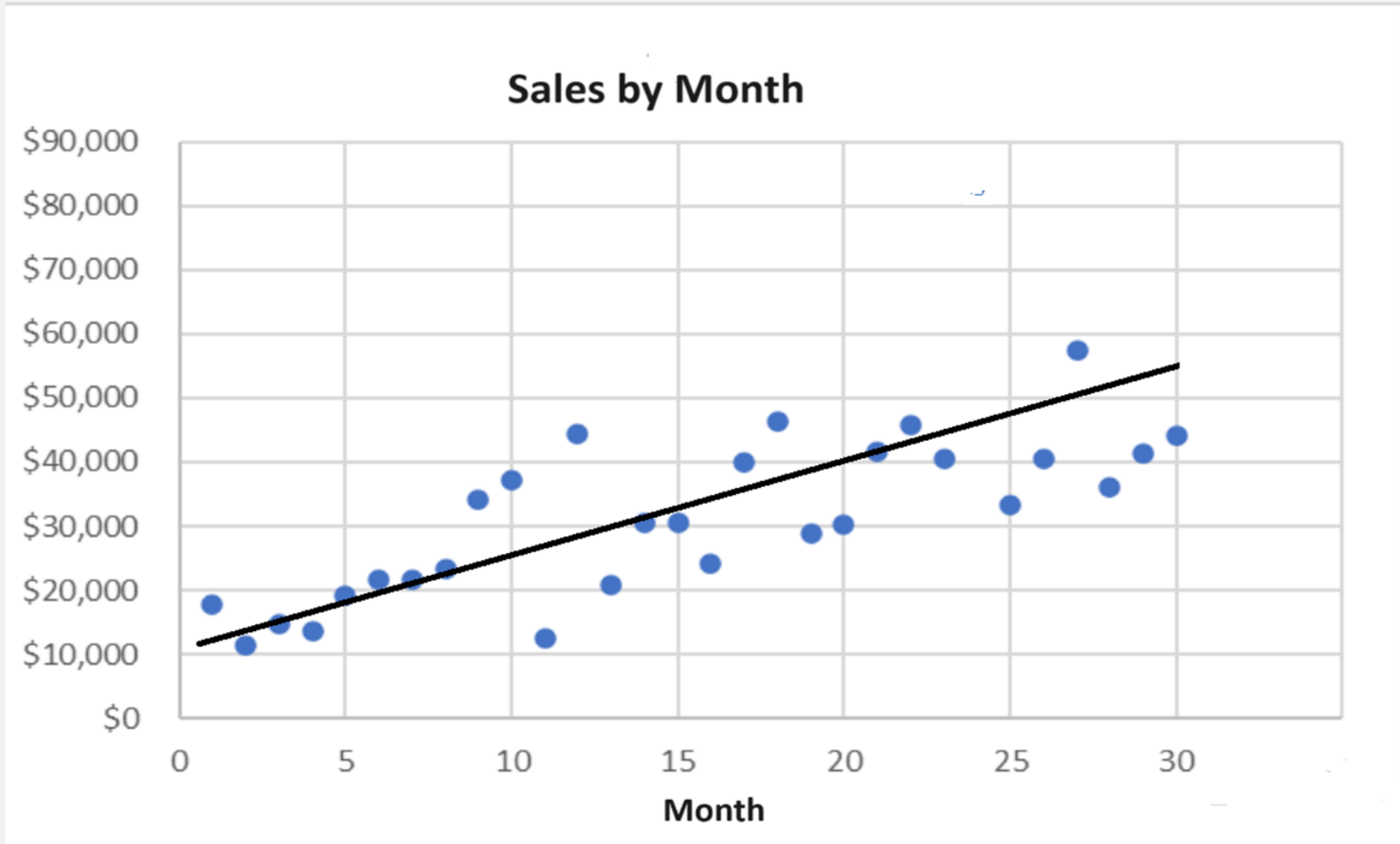


# Regression Prediction Model Using Excel

REGRESSION SUMMARY OUTPUT					
<b>Regression Statistics</b>		1. Two and a half years of sales data			
Multiple R	0.70	2. Sample Size n =1,158			
R Square	0.49	3. Derived from an account of over 22,000 records			
Standard Error	13022	4. Monthly Sales = \$19,056 + \$1,439 x MonthCount			
Observations	30				
ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	4652827901	4652827901	27.4	0.0000
Residual	28	4747670722	169559669		
Total	29	9400498623			
	<b>Coefficients</b>	<b>Standard Error</b>	<b>t Stat</b>	<b>P-value</b>	
Intercept	19056	4876.2	3.91	0.00054	
MonthCoun	1439	274.7	5.24	0.00001	

# Regression Summary

## Sales by Month



## FROM AUDIT TO FORECASTING

1. The data conversion from audit to regression uncovered a business with a healthy growth rate.
2. Next quarterly projections can be compared to what actually unfolds.
3. Any significant deviation from the trend should be carefully investigated.
4. Model can be augmented with other data to analyze customer satisfaction and basic market research.
5. One cannot do this broad systematic analysis without also being closely connected to the personnel and operations of the business.

## Allowing for Seasonal Fluctuations

Though there was a very good fit, there is a problem with the model so far:

- Data is that of a wholesaler that supplies retail outlets.
- A prediction for the next month or quarter will always be higher than the previous month or quarter.
- But business activity does have seasonal fluctuations.
- The fourth quarter of the year with its holiday activity will always be higher than the following first quarter of the next year.
- The model is not complete, it does not allow for seasonal fluctuations.



# Building the Multiple Regression Model

- Quarterly Input Variables Dummy take only the value 0 or 1.
- They can be thought of as numeric stand-ins for sorting data into mutually exclusive categories.
- In the case of quarterly adjustments, we set up the data matrix with the following dummy variables:
  - Quarter 1—1 if yes or 0 if no , Quarter 2—1 if yes or 0 if no, Quarter 3—1 if yes or 0 if no
  - You may notice the data matrix has dummies for three of the four quarters.
  - It may seem logical to set up four variables Q1, Q2, Q3, Q4. The problem with this method is that the last dummy variable (Q4) is redundant.
  - If the first three dummy variables are 0, then it is a given that Q4 has to be 1, so it is defined as a product of the first three and not random.
- The rule is the number of dummy variables necessary to represent a single attribute variable is equal to the number of levels minus one (categories -1)

# Building the Multiple Regression Model

SUMMARY OUTPUT					
<i>Regression Statistics</i>					
Multiple R		0.78			
R Square		0.60			
Standard Error		10202			
Observations		30			
<i>ANOVA</i>					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	3967955892	991988973	9.53	0.00
Residual	25	2602245521	104089821		
Total	29	6570201413			
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	
Intercept	23711	5580.98261	4.2485391	0.0003	
month	1179	218.512298	5.396289	1E-05	
Q1	-11669	5416.97035	-2.154234	0.0411	
Q2	-11917	5377.15902	-2.216226	0.036	
Q3	-10184	5926.74747	-1.718317	0.0981	

By adding the quarterly seasonal adjustment  $R^2$  increased from 49% to 60%. This indicates an increase in prediction efficiency. The new model explains an additional 11% of the variation of monthly sales.

**Projected Sales = \$23,711+ Month x \$1,179 - Q1 x \$11,669 - Q2 x \$11,917 - Q3 x -\$10,184**



# Systematically Select Customers for Follow up

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Rec_Count	VENDOR_NUMBER	amount	absamt	TxDate	DataSet	ZipCode	Customer ID	Strata	Use Excel Modulus Skip Function
1	555	\$5.13	\$5.13	12/1/2019	Acme Inc	20137	15550	1	Uses Rec_Count and Excel Mod Function
2	666	\$5.16	\$5.16	5/1/2019	Acme Inc	20134	16660	1	
3	555	\$5.25	\$5.25	9/1/2019	Acme Inc	20134	15550	1	
4	555	\$5.80	\$5.80	3/1/2019	Acme Inc	20136	15550	1	
5	680	\$6.30	\$6.30	7/1/2020	Acme Inc	20134	16800	1	
6	555	\$7.93	\$7.93	12/1/2020	Acme Inc	20134	15550	1	
7	412	\$8.00	\$8.00	1/1/2021	Acme Inc	20135	14120	1	
8	555	\$8.00	\$8.00	3/1/2021	Acme Inc	20135	15550	1	
9	3236	\$8.25	\$8.25	7/1/2019	Acme Inc	20137	42360	1	
10	2014	\$8.50	\$8.50	11/1/2019	Acme Inc	20137	30140	1	= IF(MOD(A12,10)=0,"select", " ")
11	412	\$8.75	\$8.75	7/1/2020	Acme Inc	20136	14120	1	
12	412	\$8.95	\$8.95	5/1/2020	Acme Inc	20136	14120	1	
13	680	\$9.70	\$9.70	10/1/2019	Acme Inc	20137	16800	1	
14	586	\$11.00	\$11.00	7/1/2019	Acme Inc	20134	15860	1	
15	1574	\$11.32	\$11.32	3/1/2020	Acme Inc	20136	25740	1	
16	680	\$11.50	\$11.50	5/1/2021	Acme Inc	20136	16800	1	
17	555	\$11.90	\$11.90	5/1/2021	Acme Inc	20134	15550	1	
18	555	\$12.25	\$12.25	10/1/2019	Acme Inc	20136	15550	1	
19	2869	\$12.57	\$12.57	6/1/2020	Acme Inc	20136	38690	1	
20	2698	\$12.91	\$12.91	6/1/2019	Acme Inc	20134	36980	1	select
21	555	\$13.24	\$13.24	5/1/2021	Acme Inc	20136	15550	1	
22	1461	\$14.27	\$14.27	3/1/2020	Acme Inc	20137	24610	1	
23	555	\$15.24	\$15.24	3/1/2021	Acme Inc	20135	15550	1	
24	2014	\$15.75	\$15.75	3/1/2020	Acme Inc	20135	30140	1	
25	593	\$16.47	\$16.47	12/1/2020	Acme Inc	20137	15930	1	
26	631	(\$17.67)	\$17.67	11/1/2020	Acme Inc	20134	16310	1	
27	412	\$18.60	\$18.60	7/1/2020	Acme Inc	20136	14120	1	
28	555	\$18.75	\$18.75	6/1/2020	Acme Inc	20136	15550	1	
29	3474	\$20.10	\$20.10	10/1/2019	Acme Inc	20136	44740	1	
30	1574	\$20.89	\$20.89	1/1/2019	Acme Inc	20134	25740	1	select

The process displayed is to select a subset of every tenth customer for customer feed back.

This is a quick and easy way to select customers for a opinion survey or focus group.

It is not a random sample of customers but a random sample of different levels of sales and then link that level to a customer.

It is a quick and easy way to get immediate feedback. The Springer book has a more detailed discussion of the issue of market research

## Using Regression to Measure Demographics of Customer Base

- Below is a data set that incorporates geographic areas based on zip codes:

Zip_Code	Zip_Area	Sales
0017	1	3,102
0016	1	6,658
0008	1	6,514
0012	1	10,000
0007	1	6,000
0005	1	9,634
0011	1	12,666
0003	2	35,548
0006	2	40,508
0020	2	60,074
"	"	"

The Regression line results:

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-\$30,885	\$6,135	-5.0	0000
Zip_Area	\$47,049	\$2,540	18.5	.0000

## Local Market Area Using Excel Pivot Table

- Sales =  $-\$30,885 + \$47,049 \times \text{Zip Area}$

<b>Area</b>	<b>Sum of Sales</b>
Zip Area 1	\$185,228
Zip Area 2	\$446,808
Zip Area 3	\$608,160
Zip Area 4	\$602,265
<b>Grand Total</b>	<b>\$1,842,461</b>

# Local Area Market Research

- **Step 1 Characteristics of Market Area**

- Regression is very valuable in adjusting predictions using categorical adjustments for various demographics such as geographic region, gender and other demographic factors.
- Geographic region can also be a surrogate for income distribution which is readily available from government published data.
- For example there is available through government sources income tax collections by zip code.
- Such data combined with census population data by zip can be a surrogate for socio economic characteristics.
- With a little care many other indicators of socioeconomic significance can be collected.

- **Step 2 Create a Profile of the Customer Base Using Likert scales or focus groups**

- What age are they?
- What is their income level?
- What is their education level?
- What kind of jobs do they have?
- What is their perception of your company?
- How do they rate your service?

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