
VIRGINIA SEMICONDUCTOR
Chin Ting Wong & Marcus Nogueira

BACKGROUND

Virginia Semiconductor, Inc. - Key Facts for Case Study:

- **Founded:** Established in 1978 as a pioneer in prime silicon substrate manufacturing.
- **Core Business:** Specializes in high-value silicon wafers for niche markets.
- **Global Leadership History:** Once a global leader in silicon wafer manufacturing; now a significant player in specialized markets.
- **Innovation:** Strong focus on engineering research and product development to sustain market relevance.
- **International Reach:** Expanded into global markets to diversify and capture new opportunities.
- **Growth:** Continues to experience rising demand for its specialized products.
- **Operational Excellence:** Prioritizes quality and efficiency to meet evolving industry standards.

OBJECTIVE

Question 1:

- Identify factors influencing the size of a customer's purchase.
- Analyze predictors such as company size, import percentage, distance, and central purchasing agent.
- Determine significant variables to guide customer targeting strategies.

Question 2:

- Explore relationships between sales, average hours worked per week, and number of customers.
- Investigate linear, quadratic, and interaction effects through scatter plots and regression analysis.
- Identify key predictors to improve operational efficiency and boost sales.

Question 3:

- Analyze the relationship between sales and number of employees over 10 years.
- Identify trends and inefficiencies using regression and visualization techniques.
- Provide management recommendations to sustain growth and optimize workforce planning.

#Q1: METHODOLOGY

Data

- Independent Variables: Company Size ($ millions sales), Percent of Customer Imports (% Imports), Distance from Virginia Semiconductor (Distance), Central Purchaser (*Binary variable*)
- Dependent Variable: Size of Purchase ($1,000s)

Method

- Apply stepwise (backward elimination) multiple regression analysis to predict the size of purchase based on other variables.

Steps

- Include all variables in the "full" regression model
- Drop insignificant variables; starting by variable with the largest p-value
- Evaluate model

#Q2: METHODOLOGY

Data

- Independent Variables: Hours Worked per Week, Number of Customers
- Dependent Variable: Average Sales ($ million)

Method

- Apply stepwise (backward elimination) multiple regression analysis to predict average sales based on the independent variables and any newly created variables.

Steps

- Create scatter plots (Sales vs. Hours Worked Per week & Sales vs. Number of Customers)
- Applying Tukey's Four Quadrant Approach to recode data (e.g. linearizing trend / introduce non-linearity / introduce binary variable(s))
- Include all variables (original & recoded) in the "full" regression model
- Drop insignificant variables; starting by variable with the largest p-value
- Evaluate model

#Q3: METHODOLOGY

Data

- Independent Variables: Number of Employees
- Dependent Variable: Sales ($ million)

Method

- Apply stepwise (backward elimination) multiple regression analysis to predict total sales based on the independent variable and any newly created variables.

Steps

- Create scatter plots (Sales vs. Number of Employees)
- Applying Tukey's Four Quadrant Approach to recode data (e.g. linearizing trend / introduce non-linearity / introduce binary variable(s))
- Include all variables (original & recoded) in the "full" regression model
- Drop insignificant variables; starting by variable with the largest p-value
- Evaluate model

#Q1: ANALYSIS & FINDINGS

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.877506
R Square	0.770017
Adjusted R Square	0.734635
Standard Error	87.39594
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	332453	166226.4964	21.76295	7.1E-05
Residual	13	99294.66	7638.050883		
Total	15	431747.7			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-7.771082	39.24508	-0.198014169	0.846097	-92.55493	77.01276	-92.55493	77.01276
Company Size	1.450821	0.34029	4.263479708	0.000924	0.715668	2.185973	0.715668	2.185973
Central Purchaser	109.407	52.91921	2.067435139	0.059204	-4.917968	223.732	-4.917968	223.732

#Q1: ANALYSIS & FINDINGS

Model Fit

- R-Squared = 0.7700
- Adjusted R-Squared = 0.7346
- Standard Error = 87.40

Significant Predictors

- **Company Size**
  - ❖ Coeff = 1.451: Each $1M increase in company size leads to a $1,451 increase in purchase size
  - ❖ p-value = 0.0009; Statistically significant predictor.

- **Central Purchase**
  - ❖ Coeff = 109.407 : Companies with a central purchaser spend $109.41K more on average
  - ❖ p-value = 0.0592; Marginally significant at the 5% level.

#Q2: ANALYSIS & FINDINGS

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.976628327
R Square	0.95380289
Adjusted R Square	0.90760578
Standard Error	0.750993421
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	58.22186259	11.64437252	20.64637567	0.002369702
Residual	5	2.819955596	0.563991119		
Total	10	61.04181818			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-503.5082254	161.4969826	-3.117756241	0.026318893	-918.6494354	-88.36701538	-918.6494354	-88.367015
Hours Worked	22.37113246	7.44962651	3.00298712	0.029996136	3.221257867	41.52100705	3.221257867	41.521007
Number of Customers	1.294050132	0.336647582	3.843931167	0.012075339	0.428669973	2.159430291	0.428669973	2.15943029
(Hours Worked)^2	-0.242365802	0.085865035	-2.822636744	0.036993667	-0.463088901	-0.021642703	-0.463088901	-0.0216427
(Number of Customers)^2	-0.000940319	0.000197913	-4.751171492	0.005099215	-0.001449071	-0.000431567	-0.001449071	-0.0004316
hours*customers	-0.026554515	0.007755129	-3.42412291	0.018754346	-0.04648971	-0.006619321	-0.04648971	-0.0066193

#Q2: ANALYSIS & FINDINGS

Model Fit

- R-Squared = 0.9538
- Adjusted R-Squared = 0.9076
- Standard Error = 0.751

Significant Predictors

- **Hours Worked:**
  - ❖Coeff = 22.37: Each additional hour worked per week increases sales by approximately $22.37K.
- **Number of Customers:**
  - ❖Coeff = 1.29: Each additional customer increases sales by $1.29K.
- **(Hours Worked)^2:**
  - ❖Coeff = -0.242: A quadratic relationship indicates that the effect of hours worked on sales decreases after a certain point.
- **(Number of Customers)^2:**
  - ❖Coeff = -0.00094: A quadratic effect suggests diminishing returns from additional customers on sales.
- **Hours Worked*Number of Customers:**
  - ❖Coeff = -0.0266: The interaction term suggests that the effect of hours worked per week on sales decreases as the number of customers increases.

#Q3: ANALYSIS & FINDINGS

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.984509995
R Square	0.969259931
Adjusted R Square	0.953889897
Standard Error	1.269861078
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	305.0697171	101.6899057	63.06166316	6.28E-05
Residual	6	9.675282945	1.612547158		
Total	9	314.745			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-570.59532	104.4678531	-5.461922527	0.002	-826.2189	-314.9717	-826.2189	-314.9717
Number of Employees	10.56748571	1.984774228	5.324275963	0.002	5.710918	15.42405	5.710918	15.42405
(Number of Employees)^2	-0.060752789	0.012334624	-4.925386307	0.003	-0.090935	-0.030571	-0.090935	-0.030571
(Number of Employees)^3	0.000115269	2.50686E-05	4.598167867	0.004	5.39E-05	0.000177	5.39E-05	0.000177

#Q3: ANALYSIS & FINDINGS

Model Fit

- R-Squared = 0.9693
- Adjusted R-Squared = 0.9539
- Standard Error = 1.27

Significant Predictors

- **Number of Employees**:
  - ❖Coeff = 10.57: Each additional employee increases sales by approximately $10.57M.
- **(Number of Employees)^2**:
  - ❖Coeff= -0.061: Suggests a quadratic effect where the benefit of adding employees diminishes after a certain point.
- **(Number of Employees)^3**:
  - ❖Coeff = 0.00012: Indicates a cubic effect where very large numbers of employees may slightly increase sales, following initial diminishing returns.

#Q3: MANAGEMENT RECOMMENDATION

Optimize Workforce Productivity

Observation: Diminishing returns suggest inefficiencies in resource utilization.

- ❖Implement training programs to enhance employee performance.
- ❖Leverage technology and automation to maximize efficiency and reduce reliance on workforce size for growth.

Determine the Optimal Workforce Size

- **Observation**: Sales growth plateaus beyond a specific employee count.
  - ❖Conduct cost-benefit analysis to find the "sweet spot" for workforce size.
  - ❖Continuously monitor and adjust hiring practices to align with optimal efficiency.

Invest in Data-Driven Decision-Making

- **Observation**: Advanced modeling highlights the importance of data in strategic planning.
  - ❖Use analytics to inform workforce planning, market strategies, and operational improvements.
  - ❖Leverage predictive models to anticipate sales trends and proactively align resources.

CONCLUSIONS

- **Key Findings Highlights:**
  - Company size and having a central purchaser are significantly associated with purchase size ($ thousands) at the 10% significance level.
  - Average sales ($ million) are best explained by hours worked, the number of customers, squared terms of both the variables, and an interaction term between hours and customers.
  - Sales ($ million) are effectively modeled using the number of employees and their squared and cubic terms, reflecting diminishing and compounding effects.
- **Model Strength and Predictors:**
  - Linear regression models provided meaningful insights in Q1, while incorporating non-linear terms in Q2 and Q3 improved explanatory power, reflecting the complexity of the relationships analyzed.
  - R-squared values highlighted the explanatory contribution of identified variables in understanding sales outcomes, with varying levels of effectiveness across models.
  - Transformations and interaction terms improved model fit and provided deeper insights into relationships.
- **Recommendations:**
  - Focus marketing strategies on larger companies with central purchasing agents to increase purchase size.
  - Optimize workforce productivity to balance hours worked and customer management for maximizing average sales.
  - Adjust hiring strategies based on the identified optimal workforce size to sustain growth while addressing inefficiencies.