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| **Simulation for Quarterly iPhone Sales** |
| **IDS 420, Term Report** |
| By team XYZ |

**Team members: A, B and C**

**0. Quarterly iPhone Sales**

**1. Introduction**

**1.1. Problem Description:** To create a forecast model for future sales of the iPhone 5s. We will do this by analyzing Apple’s historical data and using that data to predict 2013 4th quarter sales of the iPhone 5s and create a simulation of the model. We will then take the actual data and compare it with the forecasted data.

* Source of the problem: We are acquiring and compiling the data from Apple, Consumer Reports, and other financial press.
* Current business issues and problems: While working on the project, we encountered a huge problem that changed the course of our project. Apple does not release quarterly sales for specific iPhone models, such as the iPhone 5 or the iPhone 5s. Instead, they release quarterly sales for their products as a whole, meaning the iPhone, iPad, MacBook, etc. Because of this, we were left with no choice but to revise our objective to focus on general iPhone sales versus iPhone 5s sales.

**1.2. Goals and Objectives:** Our original objective was to compare Apple’s 4th quarter sales in 2012 of the iPhone 5, to Apple’s 4th quarter sales in 2013 of the iPhone 5s. However, because of the problem mentioned above that we encountered, we had to revise our objective of the project. Our new objective was to forecast future sales of the iPhone instead of the specific models. One of our goals was to predict demand and cost to simulate profit.

**2. Approaches/Methods/Analysis:** Our initial analysis was that with increase growth from the competition, Apple sales would suffer. However, we looked over the data and saw that despite increased competition, the iPhone remained a dominant product in the market. Our analysis showed that Apple always had control over its production and was thereby able to keep control of its costs. With that, we could find that apple was able to keep its products in supply and consumers with high demand.

**2.1. Procedures/Methods Used:**

* Summary of the steps used to analyze the problem: To forecast the future 24 quarters (the next 6 years), we had to find data on past iPhone unit sales. We did find total revenues of iPhones as well but the issue was that the revenue included other services besides the price of just the unit. Revenue sales proved to be useless in our analysis.
* We collected data from the past 5 years (2008-2013) from each quarter of the total iPhone unit sales, regardless of the model.

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| iPhone and Related Products and Services | | |  |  |
| **Year** | **Quarter** | **Units (thousands)** | | **Sales (Million)** |
| 2008 | Q1 | 2315 |  | 214 |
|  | Q2 | 1703 | 2315 | 378 |
|  | Q3 | 717 | 1703 | 419 |
|  | Q4 | 6892 | 717 | 806 |
| 2009 | Q1 | 4363 | 6892 | 1247 |
|  | Q2 | 3793 | 4363 | 1521 |
|  | Q3 | 5208 | 3793 | 1689 |
|  | Q4 | 7367 | 5208 | 2297 |
| 2010 | Q1 | 8738 | 7367 | 5578 |
|  | Q2 | 8752 | 8738 | 5445 |
|  | Q3 | 8398 | 8752 | 5334 |
|  | Q4 | 14102 | 8398 | 8822 |
| 2011 | Q1 | 16235 | 14102 | 10468 |
|  | Q2 | 18647 | 16235 | 12298 |
|  | Q3 | 20338 | 18647 | 13311 |
|  | Q4 | 17073 | 20338 | 10980 |
| 2012 | Q1 | 37044 | 17073 | 24417 |
|  | Q2 | 35064 | 37044 | 22690 |
|  | Q3 | 26028 | 35064 | 16245 |
|  | Q4 | 26910 | 26028 | 17125 |
| 2013 | Q1 | 47789 | 26910 | 30660 |
|  | Q2 | 37430 | 47789 | 22955 |
|  | Q3 | 31241 | 37430 | 18154 |
|  | Q4 | 33797 | 31241 | 19510 |

* Using the historical data we used a moving average time series model to smooth out historical data. Excel performed this function for us. This would be later used to forecast our demand in the future. Upon completing the moving average model, we found the error between the actual data and moving average. Again this would help us in determining our demand.

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| **Year** | **Level** | **Quarter** | **Actual\*** | **Forecast** | **Error** | **Absolute Error** | **(Error)2** | **% Error** | **MAD** | **MSE** |
| 2008 | 1 | Q1 | 2315.00 | #N/A |  |  |  |  |  |  |
|  | 2 | Q2 | 1703.00 | #N/A |  |  |  |  |  |  |
|  | 3 | Q3 | 717.00 | #N/A |  |  |  |  |  |  |
|  | 4 | Q4 | 6892.00 | 3418.75 | 3473.25 | 3473.25 | 12063465.56 | 50.40 | 868.31 | 4021155.19 |
| 2009 | 5 | Q1 | 4363.00 | 3941.25 | 421.75 | 421.75 | 177873.0625 | 9.67 | 84.35 | 44468.27 |
|  | 6 | Q2 | 3793.00 | 5064.00 | -1271 | 1271 | 1615441 | 33.51 | 211.83 | 323088.20 |
|  | 7 | Q3 | 5208.00 | 5182.75 | 25.25 | 25.25 | 637.5625 | 0.48 | 3.61 | 106.26 |
|  | 8 | Q4 | 7367.00 | 6276.50 | 1090.5 | 1090.5 | 1189190.25 | 14.80 | 136.31 | 169884.32 |
| 2010 | 9 | Q1 | 8738.00 | 7516.25 | 1221.75 | 1221.75 | 1492673.063 | 13.98 | 135.75 | 186584.13 |
|  | 10 | Q2 | 8752.00 | 8313.75 | 438.25 | 438.25 | 192063.0625 | 5.01 | 43.83 | 21340.34 |
|  | 11 | Q3 | 8398.00 | 9997.50 | -1599.5 | 1599.5 | 2558400.25 | 19.05 | 145.41 | 255840.03 |
|  | 12 | Q4 | 14102.00 | 11871.75 | 2230.25 | 2230.25 | 4974015.063 | 15.82 | 185.85 | 452183.19 |
| 2011 | 13 | Q1 | 16235.00 | 14345.50 | 1889.5 | 1889.5 | 3570210.25 | 11.64 | 145.35 | 297517.52 |
|  | 14 | Q2 | 18647.00 | 17330.50 | 1316.5 | 1316.5 | 1733172.25 | 7.06 | 94.04 | 133320.94 |
|  | 15 | Q3 | 20338.00 | 18073.25 | 2264.75 | 2264.75 | 5129092.563 | 11.14 | 150.98 | 366363.75 |
|  | 16 | Q4 | 17073.00 | 23275.50 | -6202.5 | 6202.5 | 38471006.25 | 36.33 | 387.66 | 2564733.75 |
| 2012 | 17 | Q1 | 37044.00 | 27379.75 | 9664.25 | 9664.25 | 93397728.06 | 26.09 | 568.49 | 5837358.00 |
|  | 18 | Q2 | 35064.00 | 28802.25 | 6261.75 | 6261.75 | 39209513.06 | 17.86 | 347.88 | 2306441.94 |
|  | 19 | Q3 | 26028.00 | 31261.50 | -5233.5 | 5233.5 | 27389522.25 | 20.11 | 275.45 | 1521640.13 |
|  | 20 | Q4 | 26910.00 | 33947.75 | -7037.75 | 7037.75 | 49529925.06 | 26.15 | 351.89 | 2606838.16 |
| 2013 | 21 | Q1 | 47789.00 | 34539.25 | 13249.75 | 13249.75 | 175555875.1 | 27.73 | 630.94 | 8777793.75 |
|  | 22 | Q2 | 37430.00 | 35842.50 | 1587.5 | 1587.5 | 2520156.25 | 4.24 | 72.16 | 120007.44 |
|  | 23 | Q3 | 31241.00 | 37564.25 | -6323.25 | 6323.25 | 39983490.56 | 20.24 | 274.92 | 1817431.39 |
|  | 24 | Q4 | 33797.00 | 31241 | 2556 | 2556 | 6533136 | 7.56 | 106.50 | 284049.39 |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | \*= Units consist of iphone handsets sales('000's units) | | | | |  |  |  |  |

* After calculating the moving average, we plotted both the actual historical data and moving average data to a graph where we can see the trend of iPhone sales. This helped us analyze the way Apple was selling their iPhones and how they would continue in the future.
* In the next step we performed a regression of our data. We used the actual data as the response variable and the moving average as the predictor variables in the simple regression model. Again using excel to perform this function, we found our regression model to be y = 913.5681429 + 1.00212963 (previous year’s output) + error term. We used this model to simulate the next 24 quarters. The error term was randomly generated with a normal distribution (mean,STD) with a mean of 953 and a standard deviation of 4941. We found the standard deviation and mean from the errors that were calculated prior. The mean was later found to be a mistake. We used a mean of 0 in our post modeling simulation.

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| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.927598935 |  |  |  |  |  |  |  |
| R Square | 0.860439784 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.85309451 |  |  |  |  |  |  |  |
| Standard Error | 5068.897338 |  |  |  |  |  |  |  |
| Observations | 21 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 1 | 3009812508 | 3009812508 | 117.1419507 | 1.4502E-09 |  |  |  |
| Residual | 19 | 488180684.2 | 25693720.22 |  |  |  |  |  |
| Total | 20 | 3497993193 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 913.5681429 | 2063.841821 | 0.442654148 | 0.663014144 | -3406.102432 | 5233.238718 | -3406.102432 | 5233.238718 |
| X Variable 1 | 1.002121963 | 0.092590058 | 10.82321351 | 1.4502E-09 | 0.808328745 | 1.195915181 | 0.808328745 | 1.195915181 |

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| **Quarter** | **Actual\*** | **Forecast** | **Error** |  |  |  |
| Q1 | 2315.00 | #N/A |  |  |  |  |
| Q2 | 1703.00 | #N/A |  |  |  |  |
| Q3 | 717.00 | #N/A |  | Error |  |  |
| Q4 | 6892.00 | 3418.75 | 3473.25 | 953.5 | **Average** |  |
| Q1 | 4363.00 | 3941.25 | 421.75 | 4940.618277 | **Standard Deviation** | |
| Q2 | 3793.00 | 5064.00 | -1271 |  |  |  |
| Q3 | 5208.00 | 5182.75 | 25.25 |  |  |  |
| Q4 | 7367.00 | 6276.50 | 1090.5 |  |  |  |
| Q1 | 8738.00 | 7516.25 | 1221.75 |  |  |  |
| Q2 | 8752.00 | 8313.75 | 438.25 | **Price** | 199 | 649 |
| Q3 | 8398.00 | 9997.50 | -1599.5 |  | 299 | 749 |
| Q4 | 14102.00 | 11871.75 | 2230.25 |  | 399 | 849 |
| Q1 | 16235.00 | 14345.50 | 1889.5 | **Average Price** | 524 |  |
| Q2 | 18647.00 | 17330.50 | 1316.5 | **Cost** | 198 | 208 |
| Q3 | 20338.00 | 18073.25 | 2264.75 |  | 218 |  |
| Q4 | 17073.00 | 23275.50 | -6202.5 | **Average Cost** | 208 |  |
| Q1 | 37044.00 | 27379.75 | 9664.25 |  |  |  |
| Q2 | 35064.00 | 28802.25 | 6261.75 |  |  |  |
| Q3 | 26028.00 | 31261.50 | -5233.5 | **Interest Rate** | 0.1 |  |
| Q4 | 26910.00 | 33947.75 | -7037.75 |  |  |  |
| Q1 | 47789.00 | 34539.25 | 13249.75 |  |  |  |
| Q2 | 37430.00 | 35842.50 | 1587.5 |  |  |  |
| Q3 | 31241.00 | 37564.25 | -6323.25 |  |  |  |
| Q4 | 33797.00 | 31241 | 2556 |  |  |  |

* After determining out demand for the next 24 quarters, we needed to find the revenue, costs, profits, and net present value. We do make a few assumptions moving forward, which will be discussed in the following section. We found revenue by taking the average price of an iPhone and multiplying it by the simulated demand. The cost was found in similar fashion, taking the average cost of an iPhone and multiplying it by the demand. The profit was then calculated by subtracting the costs from the revenue. After the profits were found for each quarter, we found the net present value of the profit with only an interest rate of 1%.

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|  |  | **Demand** | **Error** | **Revenue** | **Cost** | **Profit** | **Net Present Value** |
| 2014 | Q1 | 37648.43103 | 2866.146906 | 19727777.86 | 7830873.655 | 11896904.21 | $10,815,367.46 |
|  | Q2 | 45137.50346 | 6495.615708 | 23652051.81 | 9388600.719 | 14263451.09 | $12,966,773.72 |
|  | Q3 | 44141.42162 | -2005.430088 | 23130104.93 | 9181415.698 | 13948689.23 | $12,680,626.58 |
|  | Q4 | 50242.87907 | 5094.222843 | 26327268.63 | 10450518.85 | 15876749.79 | $14,433,408.90 |
| 2015 | Q1 | 60028.76104 | 8765.700295 | 31455070.78 | 12485982.3 | 18969088.49 | $17,244,625.90 |
|  | Q2 | 71288.99746 | 10219.28947 | 37355434.67 | 14828111.47 | 22527323.2 | $20,479,384.73 |
|  | Q3 | 73394.4846 | 1040.646384 | 38458709.93 | 15266052.8 | 23192657.13 | $21,084,233.76 |
|  | Q4 | 68051.57694 | -6412.21618 | 35659026.32 | 14154728 | 21504298.31 | $19,549,362.10 |
| 2016 | Q1 | 64866.01158 | -4243.536432 | 33989790.07 | 13492130.41 | 20497659.66 | $18,634,236.05 |
|  | Q2 | 68070.05964 | 2152.836646 | 35668711.25 | 14158572.41 | 21510138.85 | $19,554,671.68 |
|  | Q3 | 67763.88954 | -1364.180389 | 35508278.12 | 14094889.03 | 21413389.1 | $19,466,717.36 |
|  | Q4 | 77498.97939 | 8677.729238 | 40609465.2 | 16119787.71 | 24489677.49 | $22,263,343.17 |
| 2017 | Q1 | 70130.06873 | -8446.928769 | 36748156.01 | 14587054.3 | 22161101.72 | $20,146,456.11 |
|  | Q2 | 77844.71108 | 6652.260799 | 40790628.61 | 16191699.9 | 24598928.7 | $22,362,662.46 |
|  | Q3 | 90357.99291 | 11434.5301 | 47347588.29 | 18794462.53 | 28553125.76 | $25,957,387.06 |
|  | Q4 | 85640.70743 | -5822.589947 | 44875730.69 | 17813267.14 | 27062463.55 | $24,602,239.59 |
| 2018 | Q1 | 93360.29445 | 6624.292473 | 48920794.29 | 19418941.25 | 29501853.05 | $26,819,866.41 |
|  | Q2 | 96628.13108 | 2156.161395 | 50633140.69 | 20098651.26 | 30534489.42 | $27,758,626.75 |
|  | Q3 | 97640.35419 | -106.3863465 | 51163545.6 | 20309193.67 | 30854351.92 | $28,049,410.84 |
|  | Q4 | 102120.54 | 3359.428433 | 53511162.95 | 21241072.32 | 32270090.63 | $29,336,446.03 |
| 2019 | Q1 | 99281.67742 | -3969.126715 | 52023598.97 | 20650588.9 | 31373010.06 | $28,520,918.24 |
|  | Q2 | 98328.46065 | -2077.456952 | 51524113.38 | 20452319.82 | 31071793.57 | $28,247,085.06 |
|  | Q3 | 96508.16311 | -2942.515039 | 50570277.47 | 20073697.93 | 30496579.54 | $27,724,163.22 |
|  | Q4 | 97938.30306 | 311.7850611 | 51319670.8 | 20371167.04 | 30948503.77 | $28,135,003.42 |

* Assumptions: One of our few assumptions we made was that the error was normally distributed with a mean 0 and standard deviation of 4941. In this case, the variance was very high but does still help us with our model. When calculating the cost function, we could not determine the capacity Apple had for its manufacturing plants. We assumed that the demand was the amount of iPhones that were produced. Thus, we could not see a loss in profits if more units were produced than sold. On the same note, the average cost of an iPhone was also assumed. Apple does not release their costs and many analysts have speculated the cost of one unit. We too the average of the cost found by the analysts and determined the cost that way. We also assumed that the cost and price of the iPhone would remain stagnant over the next 24 quarters. This assumption is most likely not true. As technology advances, the cost of producing an item will become must cheaper.

**2.2. Software Used:**

Excel, STATA

**3. Conclusions/Findings**

**3.1. Results:** Our results were interesting in regarding how Apple remain a dominant player in the industry. From our simulation, we can assume that despite the high cost associated with iPhones, people will have a high demand for the product. Our simulation shows based on the forecast that with the increase in unit and the high cost and broad range of availability for the consumer, Apple remains and continues to lead in the smartphone industry.

**3.2. Recommendations**

* List of recommendations: Apple has enough market saturation to ensure its continuing growth; any increased exposure will not damage the brand. Apple’s marketing strategy was unique in differentiating from the other smartphones by being all encompassing. Our recommendations would be to ensure that people continue to buy the iPhone, they must continue to keep the product order quantity high and the market strategically.
* Reasoning: Our reasoning behind our recommendations would be that many early adopters are key for Apple by marketing itself as innovative and technologically advanced.

**3.3. Software: Excel**

* Ease or difficulty of use: Excel was relatively easy to use especially since we were taught everything we needed to know in order to successfully simulate and forecast the model.
* Suitability of such problems: We had many resources to use if we ran into any problems, whether it be the book, homework examples, or talking to you for additional guidance and help.

**4. References**

**A**

**B**

**C**