The DuPont Profitability Analysis Model: An E-Learning Application and Evaluation

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Agricultural Finance Markets in Transition
Proceedings of The Annual Meeting of NCT-194 Hosted by the Center for the Study of Rural America,
Federal Reserve Bank of Kansas City
October 6 - 7, 2003

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Abstract

Successful farm business managers must understand the determinants of profitability and have an overall long-term or strategic management focus. The objective of this research is to help producers understand the impacts of different production, pricing, cost control and investment decisions on their farms financial performance. This objective will be accomplished by developing and testing a computer-based training and application tool to facilitate determining the financial health of farm businesses using the DuPont profitability analysis model. The results of the two experiments indicate that the computer software was effective for teaching techniques of profitability analysis contained within the DuPont model.

Keywords: DuPont profitability analysis, e-learning, computer assisted analysis, return on equity (ROE), return on assets (ROA)

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Introduction

It is generally perceived that financial management is important as a management function of any business, including farm businesses. Poor financial practices rank second only to economic conditions as a cause of business failure, according to Dun & Bradstreet (1994). A study by Gaskill, Van Auken, and Manning (1993) examined causes of business failure in the apparel industry; they found that poor financial control is a main cause of business failure. Wichman (1983) reported that accounting capacity was an important aspect in determining small business success or failure. Lauzen (1985) characterizes the first 5 years of a business as being the critical time period. He argues that by analyzing financial statements and developing good managerial skills, a business owner can increase his chances of success. Wood (1989) specifically cites the importance of financial education and training as a determinant of whether a business will succeed.

Boehlje et al. (1999) recognize the importance for farm business managers to evaluate and monitor financial performance. They also indicate that financial management is important because of the link between managerial decisions and rates of return. They argue that the farm manager must collect accurate data for a financial evaluation and then make the appropriate adjustments if necessary. Firer (1999) agrees stating that managers need to have at least a basic understanding of how to determine the financial health of their business and the financial implications of different strategies. Plumley and Hornbaker (1991) argue that the economic environment encountered by the farm sector places much importance on finance in farm management. Mumey (1987) also argues that if concentration on farm production has proved successful to farm performance, then increased concentration on financial management might also be justified.

Profitability Analysis

Profitability analysis and assessment of the fundamental drivers of profitability is a critical component of evaluating financial performance. Performance measures like the operating profit margin, asset turnover ratio, return on assets and return on equity -- and more importantly how they are impacted by marketing, operations, investment and financing decisions -- are extremely valuable to a farm manager. The operating profit margin shows the amount that each dollar of sales yields to net income. The asset turnover rate measures the revenues generated per dollar of assets and indicates how efficiently the business uses its assets. The return on assets is a measure that managers can use to determine if capital is generating an acceptable rate of return. Return on equity helps managers determine whether or not the debt of the farm business is working for or against them. Together these measures help to show how well the farm business is performing financially. These four measures are core to the manager's analysis of business financial performance and are neatly summarized in the DuPont profitability analysis model.

The DuPont Model

The DuPont model is a common and useful way to assess and understand the drivers of profitability (Barry, 2000: p.121). The DuPont model is a ratio-based analysis that allows managers to see the interactions among the important variables in the cost-volume-profit chain (Van Voorhis, 1981). Blumenthal (1998) argues that the DuPont model is a useful way of visualizing financial information and is a good tool for getting people started in understanding how managerial decisions have an impact on financial performance.

Firer (1999) explains the DuPont model as a financial analysis and planning tool intended to develop an understanding of the factors that affect the return on equity (ROE) of the firm using straightforward accounting relationships. He argues that the DuPont model allows for the assessment of the components of ROE and assists management in examining the possible influence of strategic initiatives on financial performance. Ross et al. (1999) further identify three factors that impact the ROE as it is represented in the DuPont model. The three factors are: (1) operating efficiency (measured by profit margin); (2) asset use efficiency (measured by asset turnover); and (3) financial leverage (measured by the equity multiplier). Eisemann (1997) agrees saying that the ratios that establish ROE reflect three major performance characteristics: one income statement management feature (profit generated per sales dollar) and two balance sheet management features (sales generated per asset and the amount of solvency risk).

Application to Farm Businesses

As noted earlier, a producer needs to go beyond production management and address two fundamental concerns: (1) "How am I doing from a financial perspective?" and (2) "How can I do it better". Adages such as "lower costs" or "produce more" have often been taken as a point of fact. It is simply assumed that pursuing management strategies like these will automatically improve financial performance. An analysis usually is not done to determine which strategies warrant the most attention. The DuPont model allows producers to analyze the potential for improved performance by concentrating on variables that have the most bearing on that performance.

A very important measure of financial success to any business, farm or otherwise, is the return on equity (ROE). Assuming a producer has an income statement to obtain net income and a balance sheet to obtain owner equity, the ROE is an easy metric to calculate using the simple formula of net income divided by owner equity. However, viewing the ratio separately rather than in combination with other metrics does little to inform management on how to improve performance (Van Voorhis, 1981). If ROE is found to be less than return on assets (ROA) or has declined recently, the DuPont model suggests two basic approaches to improve performance. Analysis can be done to determine whether the ROE can be improved through the income stream or the investment stream (Figure 1).

Initially most producers may be concerned more with the income stream than the investment stream, because the production decisions made in the farm business will usually have a more direct effect on the variables in the income stream. The income stream involves variables such as selling price, expenses, net sales, profit margin, and the use of assets. If the producer discovers a major weakness in the ROE, backtracking through the income stream and determining where changes can be made will easily identify one set of potential reasons for the weakness.

For example, if the producer discovers that ROA is not satisfactory, he can track this back to asset turnover and net profit margin. The analysis can be further tracked to net sales and total cost if the net profit margin is determined to be the main reason for the low ROA. Net sales could be improved by increasing the price received (better marketing) or by increasing the volume of product sold (increasing yields or productivity). A farmer will most likely consider these actions, but the DuPont model offers an opportunity to do comparative statics and determine what options will most benefit the producer.

The second approach to improving ROE, through the investment stream, culminates in the financial leverage multiplier. Most of the backtracking through the investment stream will follow total assets. From basic accounting we know that total assets are equal to total liabilities plus owner equity. This simply means that all assets are either claimed by creditors or owners and this allows us to break the investment stream into two more sections, total debt and owner equity.

It is important for a producer to understand what changes occur in ROE as liabilities, equity and assets are restructured. For example, a producer might hypothesize that by decreasing his debt load he will increase his profitability because the interest expense of the business will decrease. However, by analyzing the investment stream of the DuPont model the producer will realize that if this reduced debt load requires an increase in owner equity to maintain the asset base of the business, the financial leverage multiplier will decline and the ROE may also decline. Again, by doing simple comparative statics the producer will see the consequences of different financing decisions.

DuPont Model Software

To help farm producers better understand the impacts of different production, pricing, cost control and investment decisions on financial performance, a computer-based financial analysis training and application tool was developed to facilitate analyzing the financial health of farm businesses. The software analysis tool was intended to introduce the DuPont profitability analysis in a user-friendly setting with audio help and instruction. The computer software was created using Microsoft Visual Basic 6.0[1] and packaged as a stand-alone program. Thus the program can be used without the assistance of an additional Microsoft application such as Excel. The computer software is segmented into two main sections: a tutorial and an analysis application.

The tutorial was developed to familiarize the user with the DuPont financial analysis model as well as how to operate the software. The tutorial begins by explaining the general organization and concepts of the DuPont model. Once this is complete, the tutorial continues by describing the formulas used to perform the profitability analysis and provides a corresponding flow chart to better visualize the calculations. The tutorial finishes by illustrating how to complete the DuPont analysis with an example farm business.

The analysis application was developed to enable the user to evaluate the profitability of their farm business. The analysis portion of the DuPont software allows the farm manager to look at areas for improvement and do preliminary long-run planning. The analysis section is divided into three levels. The Level I analysis only requires data on gross revenue, fixed expense, variable expense, interest expense, total assets and total equity (Figure 2, Panel A) to perform the DuPont analysis and is the most straightforward of the three levels of analysis. The results of the analysis are summarized as return on equity (ROE), return on assets (ROA), operating profit margin (OPM) and asset turnover ratio (ATR) as illustrated in Panel B of Figure 2. The Level I analysis follows the typical structure of the DuPont analysis described by most finance text books and publications.

The Level II analysis requires more detailed information; for each enterprise or business unit, average price, volume per unit, total units and variable cost per unit must be entered (Figure 3). Up to five enterprise classifications can be entered in the Level II analysis. The Level II

[1] Microsoft Visual Basic 6.0 is a registered trademark of Microsoft Corp. 1987-2000

analysis was designed to help the farm producers using the software with the diagnostics of specific pricing, cost control, enterprise choice, productivity, etc. decisions to improve. profitability.

The Level III analysis allows for two long-run changes to be made to the farm business: an expansion analysis and a contraction analysis (Figure 4). Level III uses the base information entered for Level II to initiate the analysis. This means that the Level III analysis can be conducted only after the Level II analysis has been completed. The Level III analysis was intended to assist the farm producer with strategic positioning decisions related to growth or downsizing the business as well as different business ventures such as contract production or custom farming.

Audio instruction and help sections are also included in the computer software. Audio instruction is included throughout the tutorial and the analysis to provide guidance and instruction in the use of the computer program and interpretation of the results.

Software Test

An experiment was conducted to test the differences in knowledge and understanding of profitability analysis prior to and after use of the computer assisted educational program. Two sample groups were used: Purdue graduate students and farm producers. The two groups were tested separately; however, the same experiment was applied to both groups.

For the experiment, each participant was given initial instructions by the administrator and an instructional sheet. The instructions for the experiment were as follows: 1) Take Test #1; 2) Go through the tutorial; 3) Go through the analysis using the provided case study; 4) Take Test #2. These instructions were meant to guide the test participant through the experiment. The approximate time to complete the experiment was about 1 hour.

Test #1 and Test #2 were identical and consisted of 10 multiple choice questions based on ideas and principles of financial analysis that are components of the DuPont profitability analysis model. The questions were categorized into three areas of learning: 1) calculation procedures of the DuPont model, 2) financial concepts contained in the DuPont model, and 3) application of financial concepts to managerial decisions. Calculation based questions were included to determine how well the participants learned the mechanical and operational details included in the DuPont model. Application based questions were included to help determine how well the participants were able to combine calculation and conceptual questions to help solve real life problems. Conceptual based questions were included to evaluate the participant's ability to comprehend fundamental financial concepts that are embodied in any business.

Summary Results

Graduate Students

A random sample of 20 Purdue University Agricultural Economics graduate students was used for the first experimental group. To obtain the sample, an e-mail was sent to all graduate students within the Department of Agricultural Economics asking individuals interested in participating in the experiment to respond. None of the graduate student subjects were pre-selected and their knowledge of financial concepts was unknown to the experiment administrator.

Table 1 contains the results from the graduate student group. Test #1 and Test #2 are the respective test scores for participants before and after the use of the computer program. Other information gathered includes: educational level, academic area, rating of knowledge of financial concepts, rating of computer skills, and previous participation in an experiment of this nature. Self-assessment of financial concepts and computer skills were based on a scale of 1 to 5, with 1 being poor and 5 being excellent.

There were fourteen MS and six PhD students that participated in the experiment. Different academic areas included: agribusiness, international development, agricultural marketing, and agricultural finance. None of the graduate student participants indicated that they had ever participated in a study of this nature. The average self-assessment rating of knowledge of financial concepts before the experiment was 2.25 and the average self-assessment rating of computer proficiency was a 3.85 (Table 1).

The results of the graduate student tests are summarized in Table 1. The averages are the average score of all the participants out of 10 points. Overall the scores increased for the graduate students, after using the software; 17 of the 20 graduate students increased their score from the first test to the second. The average score for the first test was a 4.25 and the standard deviation was 1.74. The average score for the second test was 6.65 and the standard deviation was 1.79. The minimum score on Test #1 was a 0 and the maximum score was a 7. The minimum score on Test #2 was a 3 and the maximum score was a 10.

The average test scores for the three areas of learning also increased from the pre-test to the post-test (Table 1). The average score for the calculation based questions on the pre-test was 1.3 and the average score for the post-test was 2.35 out of three questions. The average score for the application questions was 0.8 on the first test and 1.85 on the second test out of three questions. The final area of learning, conceptual, exhibited an average first test score of 2.15 and an average second test score of 2.50 out of three questions.

Overall the calculation and application questions exhibited a larger number of test participants increasing their score from the pre-test to the post-test than the conceptual questions. The calculation questions had 15 people increase their score and the application questions had 14 people increase their scores from the first test to the second. However, the initial scores for the conceptual based questions was over a full point higher than the average score for the application based questions and was almost a full point higher than the average score for the calculation questions. The conceptual based questions also had the highest post-test average (2.5/3) of the three areas of learning.

Farm Producers

A random sample of 20 farm producers was used for the second experimental group. None of the farm producer test subjects were pre-selected and their knowledge of financial concepts was unknown to the experiment administrator. Participants for the farm producer group were recruited through ag extension educators and through leads provided by faculty and students in the Department of Agricultural Economics at Purdue University. Participants for the farm producer group came from Indiana, Tennessee, and North Dakota. Each participant was given initial instructions by the test administrator to follow the instructional sheet provided on the front of the test packet.

Table 2 contains the results from the farm producer group. Different academic areas of the farm producers included agribusiness, accounting and ag science (Table 2). None of the farm producer participants indicated that they had ever participated in a study of this nature. The average self-assessment rating of financial concepts before the experiment was 2.37 and the average self-assessment rating of computer proficiency was 3.11 (Table 2).

Overall the scores increased for the farm producers, with 13 of the 20 farm producers increasing their score from the first test to the second and 2 of the participants exhibiting a lower score on the second test. The average score for the first test was a 3.68 and the standard deviation was 1.95. The average score for the second test was 5.21 and the standard deviation was 1.05. The minimum score on Test #1 was a 0 and the maximum score was an 8. The minimum score on Test #2 was a 2 and the maximum score was a 9.

The average test scores for the three areas of learning also increased from the pre-test to the post-test (Table 4). The average score for the calculation based questions on the pre-test was 1.50 and the average score for the post-test was 2.20. The average score for the application questions was 0.45 on the first test and 1.00 on the second test. The final area of learning, conceptual, exhibited an average first test score of 1.80 and an average second test score of 1.95. The calculation questions had 13 people increase their score from the first test to the second. The application and conceptual questions had 8 people increase their scores from the first test to the second.

Sign Test

The graduate student and farm producer test results were examined to determine if the increase in test scores from Test #1 to Test #2 are statistically significant. To test for the differences in the paired data, a sign test was used. The sign test for the differences is a non-parametric method for determining if two columns of observations are significantly different from one another (Siegel, 2003). The sign test requires that the data set is a random sample from the population of interest and is a two-tailed test. To determine whether or not the two samples are significantly different, the sign test uses a ranking system based on a modified sample of the data. The ranks for the sign test are included in Table 3.

The procedure for the sign test is as follows[2]:

1) Find the modified sample size, m, by calculating the sum of data values that change between the first and second columns.

2) Establish the limits for m.

3) Count the data values that went up and compare to the limit.

4) If this count falls outside the limits, then the two samples are significantly different. If the count falls within the limit, the two samples are not significantly different.

[2] Andrew Siegel, "Practical Business Statistics" McGraw-Hill (2003)

Sign Test – Graduate Students

The graduate student group contained 20 participants; however the number of data values that went either up or down is 18, thus the modified sample size is 18. It should be noted that it does not matter if a test score decreased from the first test to the second when determining the modified sample size. Because absolute values are assigned, it only matters that the scores are different. The limits for testing at the 10% level at a modified sample size of 18 are 4.9 and 12.1, as shown in Table 3. The graduate student group had 17 participants with higher test scores on the second compared to the first test, which indicates that there is a statistically significant difference between the test scores. Thus the computer program was statistically significantly helpful in improving the participants understanding of profitability analysis.

Sign tests were also conducted on the respective categories of questions (calculation based, conceptual based, and application based) to determine if there are differences in these areas of learning. The modified sample size for the calculation based questions is 18 and the limit for this sample size at the 10% level is therefore 5 and 13. The number of test scores that increased from the first test to the second for the calculation based questions is 15. Thus, there is a statistically significant increase from Test #1 to Test #2 in the calculation based questions.

The modified sample size for the application based questions was 16 and the limit for this sample size at the 10% level is therefore 4.5 and 11.5. The number of test scores that increased from the first test to the second for the application based questions is 14. Thus, there is a statistically significant increase from Test #1 to Test #2 in the application based questions.

The modified sample size for the conceptual based questions was 11 and the limit for this sample size at the 10% level is therefore 2.5 and 8.5. The number of test scores that increased from the first test to the second for the conceptual based questions is 8. Thus, the increase from Test #1 to Test #2 in the conceptual based questions is not significant. However, it should be noted that the number of participants that increased their scores is close to the upper limit of 8.5.

Sign Test – Farm Producers

The farm producer tests were also examined to determine if the increase in test scores from Test #1 to Test #2 are significant. The farm producer group contained 20 participants; however the number of data values that went either up or down is 15, thus the modified sample size is 15. The limits for testing at the 10% level at a modified sample size of 15 are 4.1 and 10.9, as shown in Table 3. The farm producer group had 13 participants with higher test scores on the second compared to the first test, which indicates that there is a statistically significant difference between the scores on the two tests for this group.

Sign tests were also conducted on the respective categories of questions (calculation based, conceptual based, and application based) for the farm producers. The modified sample size for the calculation based questions is 15 and the limit for this sample size at the 10% level is therefore 4.1 and 10.9. The number of test scores that increased from the first test to the second for the calculation based questions is 13. Thus, there is a statistically significant increase from Test #1 to Test #2 in the calculation based questions.

The modified sample size for the application based questions is 10 and the limit for this sample size at the 10% level is therefore 2.1 and 7.9. The number of test scores that increased from the first test to the second for the application based questions is 8. Thus, there is a

statistically significant increase from Test #1 to Test #2 in the application based questions. The modified sample size for the conceptual based questions is 12 and the limit for this sample size at the 10% level is therefore 2.9 and 9.1. The number of test scores that increased from the first test to the second for the conceptual based questions was 9. Thus, the increase from Test #1 to Test #2 in the conceptual based questions is not statistically significant. However, it should be noted that the number of participants that increased their scores is close to the upper limit of 9.1.

Conclusions

The modern farm business manager must function in the critically important role of general manager, understand the determinants of profitability and have an overall long-term and strategic management focus. The objective of this research was to help producers understand the impacts of the different production, pricing, cost control and investment decisions on their farms financial performance. This objective is accomplished by developing a computer-based financial analysis training and application tool to facilitate determining the financial health of farm businesses. The tool was based on the DuPont Financial Analysis Model for assessing determinants of profitability and financial performance. The computer software is structured into two main sections: a tutorial and an analysis application. The tutorial was developed to familiarize users with the DuPont model as well as how to operate the software.

The computer-based educational tool was tested in two pre-test/post-test experiments; one with 20 graduate students and one with 20 farm producers. The financial test used for the experiments consisted of 10 multiple choice questions divided into 3 areas of learning: application, calculation, and conceptual. The results of the two experiments indicate that the computer software was effective for teaching techniques of profitability analysis contained within the DuPont profitability analysis model. Analysis of the graduate student group and the farm producer group indicates that the improvement associated with the overall test scores is statistically significant. Analysis of the categories of questions indicate that both the graduate student group and the producer group had a statistically significant improvement in test scores for the calculation and application based questions, but did not have significant improvements in test scores for conceptual based questions.

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Figure 1. DuPont Financial Analysis Model (Van Voorhis)

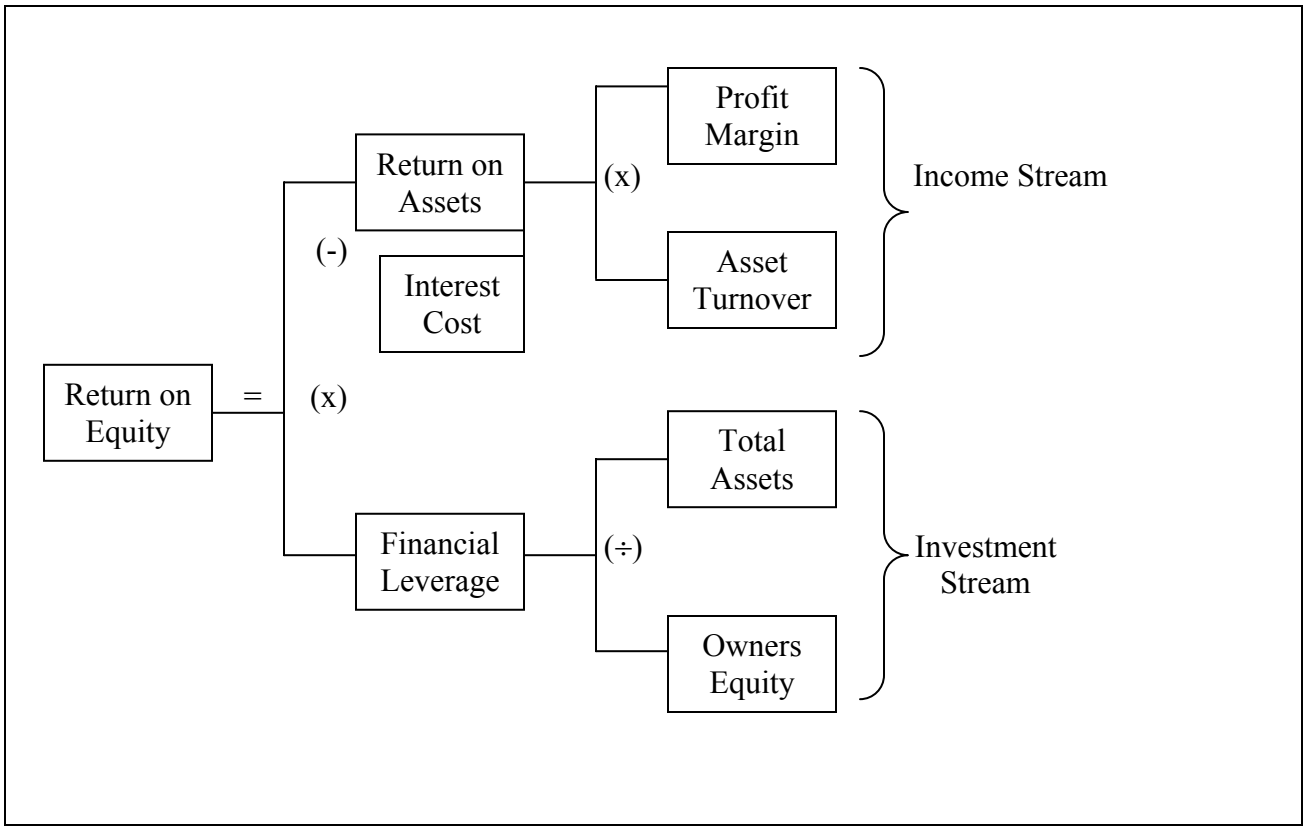
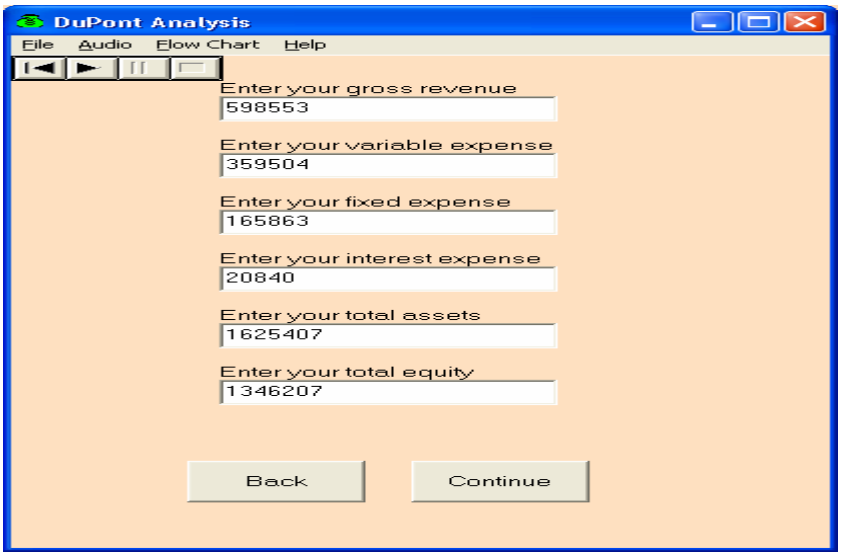


Figure 2. Level I DuPont Analysis Software Screenshots

Panel A. Input Data



Panel B. Analysis Results

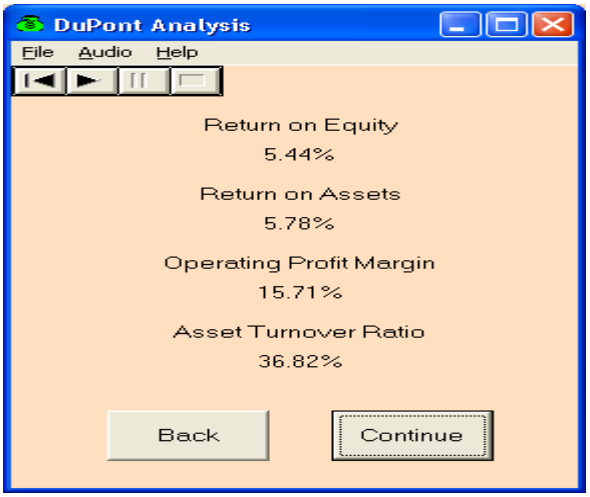
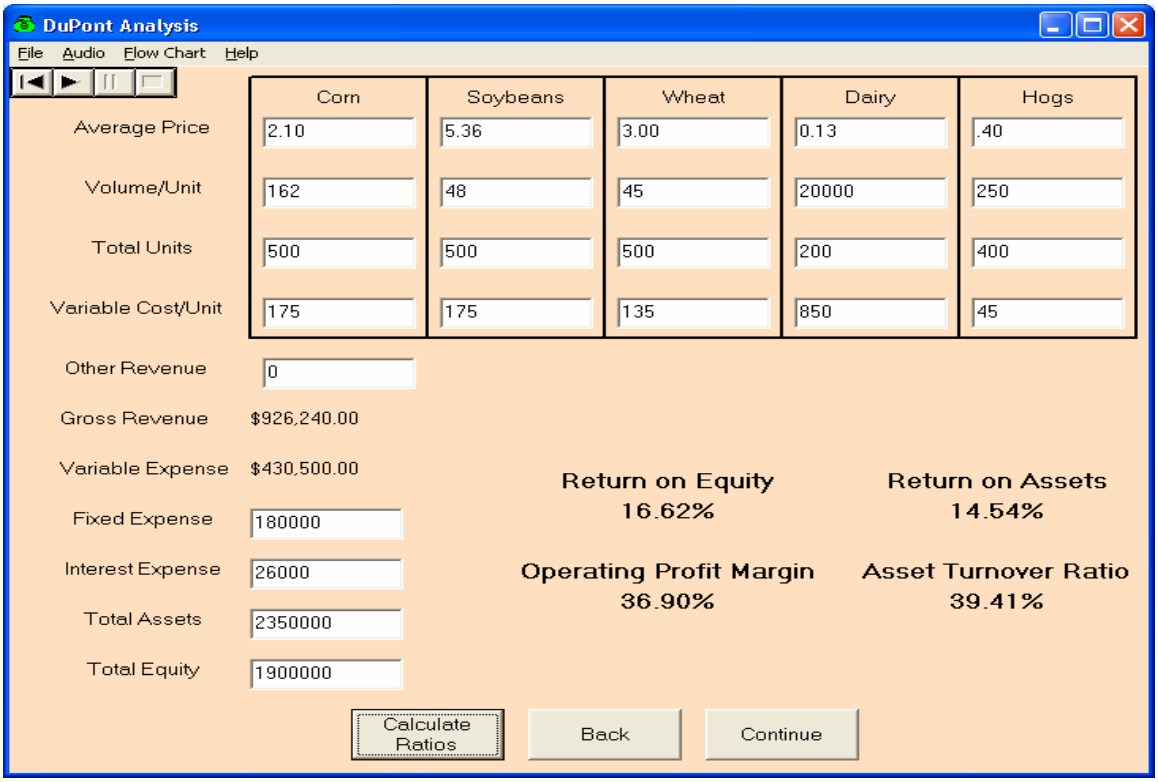


Figure 3. Level II DuPont Analysis Software Screenshots

Panel A. Input Data



Panel B. Analysis Results

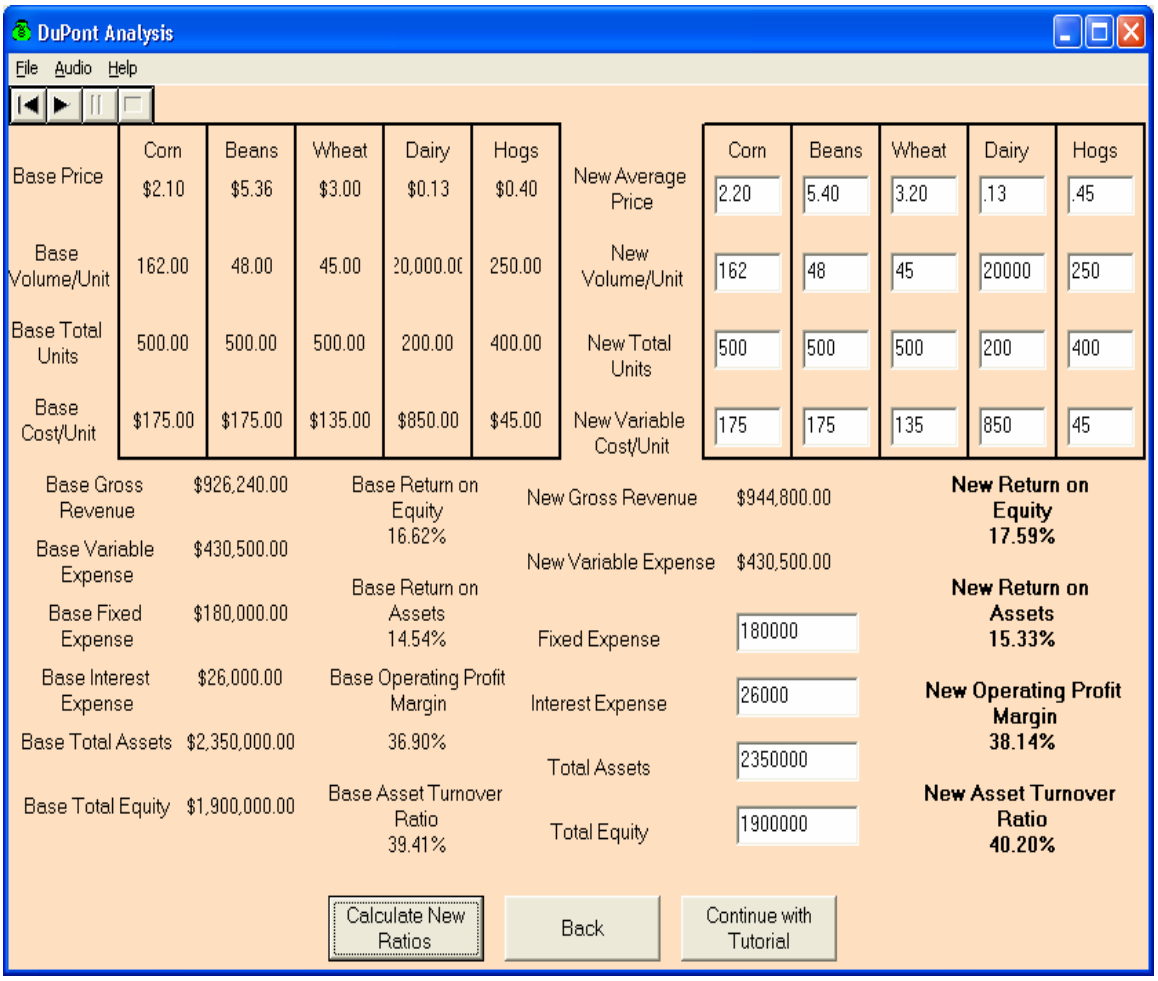
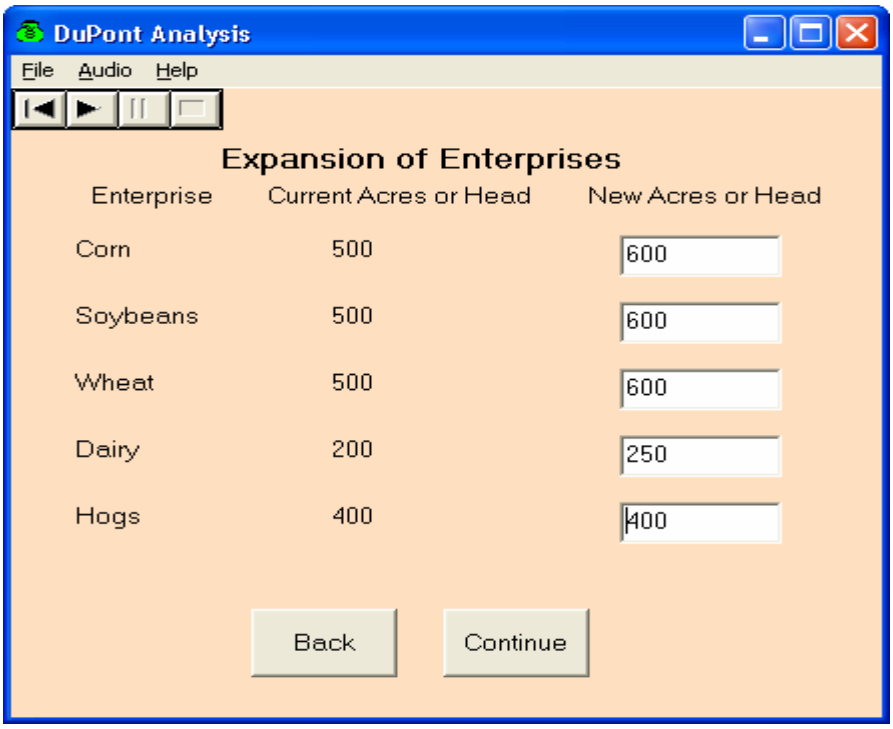
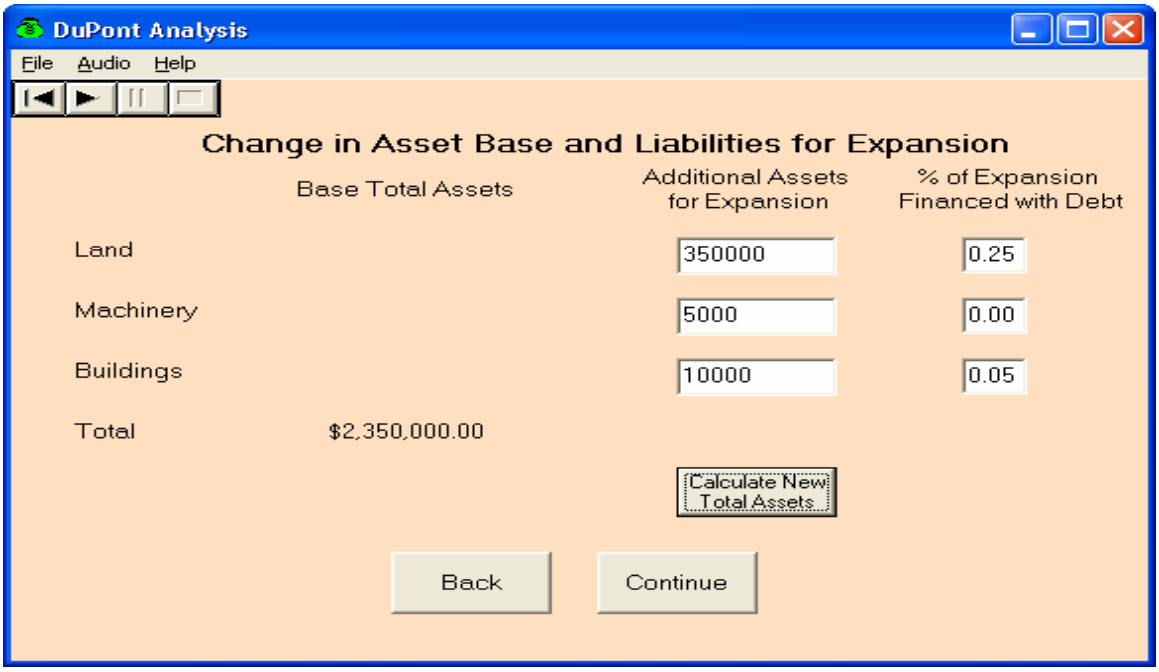


Figure 4. Level III DuPont Analysis Software Screenshot.

Panel A Input Data





Panel B. Analysis Results

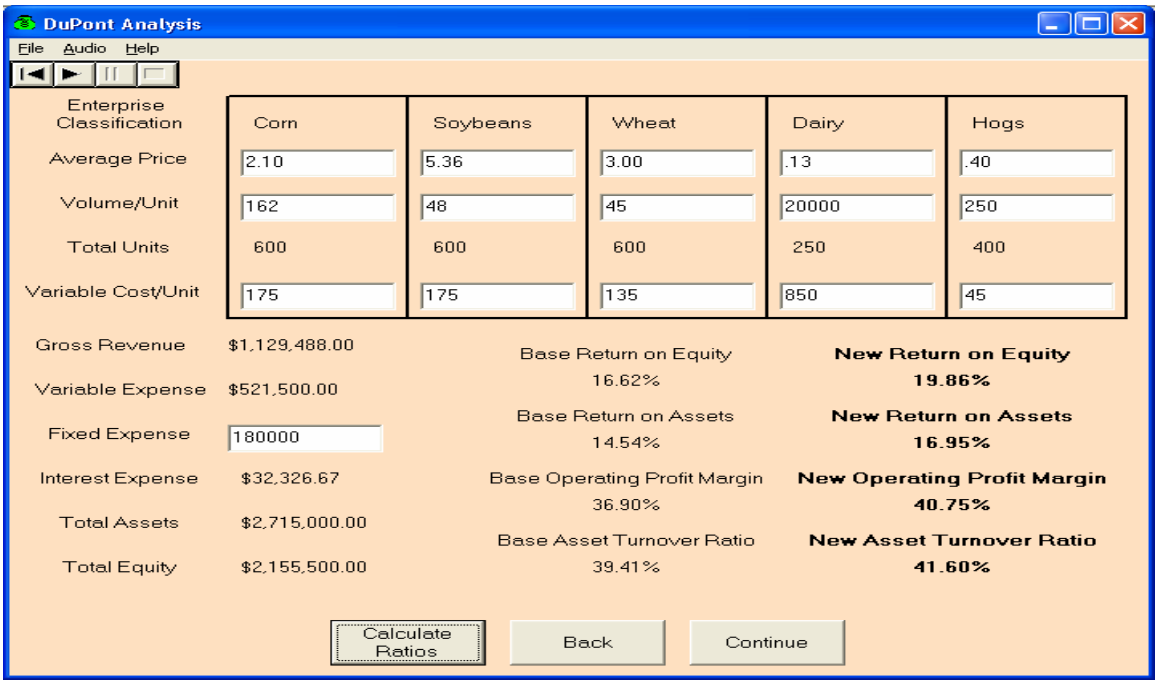


Table 1. Results from Graduate Student Group

	Overall		Calculation		Application		Conceptual		Concepts	Computer
	Test #1	Test #2	Test #1	Test #2	Test #1	Test #2	Test #1	Test #2		
Average	4.25	6.65	1.30	2.35	0.80	1.85	2.15	2.50	2.25	3.85
Std Dev.	1.74	1.79	0.92	0.93	0.77	1.23	0.93	0.83	1.07	0.59
Min	0	3	0	0	0	0	0	0	1	3
Max	7	10	3	3	2	4	3	3	4	5
Median	4	6	1	3	1	2	2	3	2	4
Increases	17		15		14		8			

Table 2. Results from the Farm Producer Group

	Overall		Calculation		Application		Conceptual		Concepts	Computer
	Test #1	Test #2	Test #1	Test #2	Test #1	Test #2	Test #1	Test #2		
Average	3.68	5.21	1.50	2.20	0.45	1.00	1.80	1.95	2.37	3.11
Std Dev.	1.95	2.02	0.89	0.83	0.60	1.08	1.06	0.83	1.12	1.05
Min	0	2	0	0	0	0	0	0	1	1
Max	8	9	3	3	2	3	3	3	4	5
Median	4	5	2	2	0	1	2	2	2	3
Increases	13		13		8		8			

Table 3. Ranks for the Sign Test*

	10% Test Level		
	Sign Test is Significant if Number is Either:		
Modified Sample Size, m	Less than	or	More than
6	0.5		5.5
7	0.9		6.1
8	1.3		6.7
9	1.7		7.3
10	2.1		7.9
11	2.5		8.5
12	2.9		9.1
13	3.3		9.7
14	3.7		10.3
15	4.1		10.9
16	4.5		11.5
17	4.9		12.1
18	5.3		12.7
19	5.7		13.3
20	6.1		13.9

*Adapted from Andrew Siegel, “Practical Business Statistics” McGraw-Hill (2003)