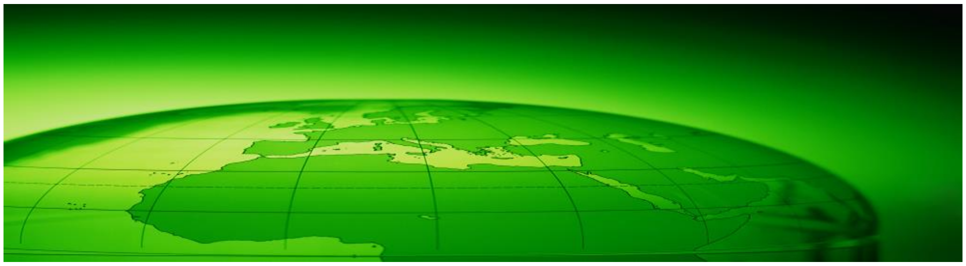

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BUDGET VARIANCE ANALYSIS OF *n*-VARIABLE PRODUCTS WITH ZERO OR *n* RESPONSIBILITY CENTERS

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BUDGET VARIANCE ANALYSIS OF *n*-VARIABLE PRODUCTS WITH ZERO OR *n* RESPONSIBILITY CENTERS

ABSTRACT

This article aims to propose a new set of budget variance analysis models, specifically, those for *n*-variable products with zero or *n* responsibility centers. We discuss the benefits of these new models over the biased, textbook model which is commonly used. We justify the mathematics of the proposed models with a formal proof. In doing so, we demonstrate that the associated differences of products can be expressed as a function of averages and differences of individual values. The models can be used in all Business disciplines currently using variance analysis, such as Accounting, Economics, Finance, Operations Management and Marketing.

INTRODUCTION

Variance analysis is a well-known and widely-used accounting tool for tracking business performance. Unfortunately, the most common model (used for the product of two variables) is biased in favor of one of its component variables and can yield misleading results. We show this with a demonstration using two-variable (unit price and quantity sold) revenue, including a numerical example. We propose a new set of unbiased models that incorporate the concept of a responsibility center (i.e., accountable manager, decision maker, department, etc.), supporting them with a mathematical proof. For an n-variable product, there can be $0, 1, 2, \dots, n$ responsibility centers and the models differ based on both the number and combination of responsibility centers. We focus on a proposed set of models for an n-variable product with n responsibility centers. For such models, the variance of each component variable can be expressed as simply as a function of averages and differences of individual values.

Consider first, two-variable revenue (i.e., revenue is calculated as the product of two variables, unit price and quantity sold). Let p be the unit price of a product and q be the quantity sold of that product.

Furthermore, let

- p_b be the budgeted unit price,
- p_a be the actual unit price,
- q_b be the budgeted quantity sold, and
- q_a be the actual quantity sold.

Define the difference of unit price and the difference of quantity sold as

$$\Delta p = p_a - p_b \qquad \text{and} \qquad \Delta q = q_a - q_b.$$

Define the average unit price and the average quantity sold as

$$\bar{p} = \frac{p_a + p_b}{2} \qquad \text{and} \qquad \bar{q} = \frac{q_a + q_b}{2}.$$

The expression

$$p_a q_a - p_b q_b$$

is the difference of actual and budgeted revenues. Five key observations concerning this formula are given next. First, the most commonly-found variance analysis model for this expression is captured by

$$p_a q_a - p_b q_b = \Delta p q_a - \Delta q p_b \tag{1}$$

where the first term on the right-hand side of the equation is the portion of the difference in revenue corresponding to the difference in unit price (i.e., price variance) and the second term is the portion of the difference in revenue corresponding to the difference of quantity sold (i.e., quantity variance). Even though the model is ubiquitous in textbooks and practice, criticisms include "... the textbook example is solved by arbitrarily adding the joint variance to the price variance. There is no theoretical justification for so doing." (Kloock, J. & Schiller, U., 1997), and ". . . the conventional two-variance analysis (price and quantity) inflates variances in three of the four possible economic situations." (Mitchell, T. & Thomas, M., 2005). Such comments lead to an obvious question, "Why is Equation 1 used, as opposed to

$$p_a q_a - p_b q_b = \Delta p q_b - \Delta q p_a?" \tag{2}$$

Second, we build upon Sorochuk et al (2023) and incorporate the concept of responsibility centers. We propose 1) Model 1 is appropriate for a firm with a decision maker responsible for unit price, but there is no decision maker responsible for quantity sold (e.g., a pricing manager sets the price for its product, but there is no active sales effort beyond making the product available for sale), 2) Model 2 is appropriate for a firm with a decision maker responsible for quantity sold, but there is no decision maker responsible for setting unit price (e.g., a firm that has an active sales force responsible for selling a pure commodity at a spot price determined by the market), and 3) for a firm with decision makers accountable for unit price and quantity sold (e.g., a cartel that can both ration units sold in the marketplace and set the selling price) the difference of revenues can be partitioned as

$$p_a q_a - p_b q_b = \Delta p \bar{q} + \Delta q \bar{p}. \tag{3}$$

As with Models 1 and 2, the first term on the right-hand side of the equation is the price variance and the second term is the quantity variance. Third, we illustrate the application of a generalization of this formula to the case of more than two factors (see Result section). Fourth, the application of this formula is not limited to just variance analysis. It can also be applied to two-period horizontal analysis, for example, comparing the revenues from two time periods. An example is a four-factor planning model which appears in Marketing textbooks (Spiro et al., 2003). Finally, the models discussed in this article and the algorithm used to generate them are not limited to just accounting applications. The algorithm can be used to generate a solution to the well-known Bankruptcy Problem in game theory (Aumann and Maschler, 1985) with n creditors collectively having a sum of claims greater than the value of the bankrupt firm. Another obvious game-theoretic application is executive compensation. Consider n executives discussing *ex ante* how to assign credit or blame should a revenue or spending variance occur. The models discussed in this article are neutral and can be agreed upon in advance to calculate unbiased variances after actual results are recognized.

We continue with a numerical example demonstrating the bias inherent to Models 1 and 2. Where applicable, the marketing department is responsible for setting unit price and the sales department is responsible for quantity sold. Shown in Table 1 are the three models discussed above. Model 1 corresponds to Equation 1 and is the proposed model for when the marketing department is the only responsibility center. Model 2 corresponds to Equation 2 and is the proposed model for when the sales department is the only responsibility center. Model 3 corresponds to Equation 3 and is the proposed model for when there are two separate responsibility centers: the marketing department and sales department.

TABLE 1

Variance Models for Two-Variable Revenue

Variance	Responsibility Center(s)		
	Marketing (1)	Sales (2)	Marketing and Sales* (3)
Price	$\Delta p q_a$	$\Delta p q_b$	$\Delta p \bar{q}$
Quantity	$\Delta q p_b$	$\Delta q p_a$	$\Delta q \bar{p}$
Revenue	$p_a q_a - p_b q_b$		

*Also applicable for zero responsibility centers.

Table 2 shows the parameters for the two, mirror-image cases used in the example. The motivation for this setup is as follows. One might intuitively think that the price and quantity variances for a given case would be the mirror image of the respective variances of the other case, given the parameters are mirror images of each other. Showing otherwise would justify investigation. As seen in Table 3, both models demonstrate a bias in favor of one component variable. A discussion follows.

Model 1 is the standard textbook model and is being used by most firms. That said, we propose it for a firm that has a pricing responsibility center (Marketing), but no sales responsibility center. As an example, consider a firm that sells products on Amazon.com. The Marketing department sets the price, but there is no analogous responsibility center playing an active role in promoting sales. The bias exists in favor of the only responsibility center (Marketing) that exists. There is \$200 worth of credit in Case 1, but only \$100 worth of blame in Case 2.

TABLE 2

Parameters for Two-Variable Revenue Example

Variable	Case 1		Case 2	
	Budgeted	Actual	Budgeted	Actual
Unit Price, p	\$10	\$11	\$11	\$10
Quantity Sold, q	100	200	200	100

TABLE 3

Results of Two-Variable Revenue Example

Variance	Case 1		
	Responsibility Center(s)		
	Marketing (1)	Sales (2)	Marketing and Sales* (3)
Price	\$200	\$100	\$150
Quantity	\$1000	\$1100	\$1050
Revenue	\$1200		

Variance	Case 2		
	Responsibility Center(s)		
	Marketing (1)	Sales (2)	Marketing and Sales* (3)
Price	(\$100)	(\$200)	(\$150)
Quantity	(\$1100)	(\$1000)	(\$1050)
Revenue	(\$1200)		

Model 2 is for a firm that has a sales responsibility center (Sales), but no pricing responsibility center. As an example, consider a firm that employs a sales department and sells a pure commodity. The sales department is active and accountable, but the selling price is determined by an outside agency, such as a spot price on a world market. Similar to Model 1, bias exists in favor of the only responsibility center that exists. There is \$1100 worth of credit in Case 1, but \$1000 worth of blame in Case 2.

Model 3 is our proposed model for a firm that employs both a pricing responsibility center (Marketing) and a separate sales responsibility center (Sales). The results found using Model 3 demonstrate its unbiased nature. For both responsibility centers, the respective price and quantity variance for a given case are the same magnitude as those for the other case (\$150 credit vs. \$150 blame and \$1050 credit vs. \$1050 blame). However, if Model 1 is being used instead, it is apparent the impacts of the resulting bias can be significant. The Sales responsibility center is receiving a dearth of credit when things are good (\$1000 vs. \$1050), and a disproportionate amount of blame when things are bad (\$1100 vs. \$1050). Conversely, the Marketing responsibility center is receiving excess credit when things are good (\$200 vs. \$150), and a disproportionate amount of blame when things are bad (\$100 vs. \$150). This highlights the potential impact of using a biased model.

RESULT

The theorem below generalizes the example in the introduction to apply to more than just the $n = 2$ variables, unit price and quantity sold. The theorem considers n variables that can each assume two values. The result indicates that the difference of the products can be written as a function of the averages and differences between the two values. Specific results for $n = 2, 3$ and 4 follow.

Theorem 1. Consider the variables x_i, for $i = 1, 2, \dots, n$ that can each only assume the two values $x_{i,1}$ and $x_{i,2}$, for *i* = 1*,* 2*, . . . , n.* Define the difference of x_i as

$$\Delta x_i = x_{i,2} - x_{i,1}$$

and the average of x_i as

$$\bar{x}_i = \frac{x_{i,2} + x_{i,1}}{2}$$

for $i = 1, 2, \dots, n$. The difference of the products can be expressed as

$$\prod_{i=1}^{n} x_{i,2} - \prod_{i=1}^{n} x_{i,1} = \sum_{d=1, d\ odd}^{n} \frac{1}{2^{d-1}} \sum_{S \subseteq [n], |S|=d} \prod_{j \in S, k \in S'} \Delta x_j \bar{x}_k,$$

where $[n] = \{1, 2, \dots, n\}$, S is any subset of $[n]$, and S' is the complement of S. The terms in the implementation of the right-hand sides of Equation 4 for $n = 2, 3, \dots, 6$ are given in Table 4.

As specific examples, we generate and present our proposed models for two-variable revenue (the product of unit price p and quantity sold q), three-variable direct materials spending (the product of unit cost c, quantity sold q and usage u) and four-variable direct materials spending (the product of unit cost c, quantity sold q, usage u and exchange rate, x) using the results in the first three columns of Table 4. See Tables 5, 6 and 7. Note that for any term in Table 4 that includes more than one Δ factor, the term is divided equally among the respective variances for each Δ factor. For example, $\Delta x_1 \Delta x_2 \Delta x_3 / 4$ is divided equally among Δx_1 variance, Δx_2 variance and Δx_3 variance.

DISCUSSION

A formal proof of Theorem 1 is given in the appendix. We give the motivation associated with the proof here. The $1/2^{d-1}$ factor in the result is used to account for the 2 in the denominator of the averages. So temporarily writing $x_{i,1}$ as b_i and $x_{i,2}$ as a_i, we need to show that

$$\prod_{i=1}^{n} x_{i,2} - \prod_{i=1}^{n} x_{i,1}$$

is a function of the averages and differences of the b_i and a_i, values. The choice of the variables' names a_i and b_i is consistent with their interpretation as *actual* and *budgeted* values. When $n = 4$, for example, we want to show that the difference of the products is

TABLE 4

Terms on the Right-Hand Sides of Equation 4.

$n = 2$	$n = 3$	$n = 4$	$n = 5$	$n = 6$
$\Delta x_1 \bar{x}_2$ $\bar{x}_1 \Delta x_2$	$\Delta x_1 \bar{x}_2 \bar{x}_3$ $\bar{x}_1 \Delta x_2 \bar{x}_3$ $\bar{x}_1 \bar{x}_2 \Delta x_3$	$\Delta x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \bar{x}_4$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \bar{x}_4$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \Delta x_4$	$\Delta x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \bar{x}_5$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \bar{x}_5$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \bar{x}_5$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \bar{x}_5$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \Delta x_5$	$\Delta x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \bar{x}_5 \bar{x}_6$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \bar{x}_5 \bar{x}_6$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \bar{x}_5 \bar{x}_6$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \bar{x}_5 \bar{x}_6$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \Delta x_5 \bar{x}_6$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \bar{x}_5 \Delta x_6$
	$\Delta x_1 \Delta x_2 \Delta x_3$	$\Delta x_1 \Delta x_2 \Delta x_3 \bar{x}_4/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \Delta x_4/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \Delta x_4/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \Delta x_4/4$	$\Delta x_1 \Delta x_2 \Delta x_3 \bar{x}_4 \bar{x}_5/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \Delta x_4 \bar{x}_5/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \Delta x_5/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \Delta x_4 \bar{x}_5/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \Delta x_5/4$ $\Delta x_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \Delta x_5/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \Delta x_4 \bar{x}_5/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \bar{x}_4 \Delta x_5/4$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \Delta x_4 \Delta x_5/4$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \Delta x_4 \Delta x_5/4$	$\Delta x_1 \Delta x_2 \Delta x_3 \bar{x}_4 \bar{x}_5 \bar{x}_6/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \Delta x_4 \bar{x}_5 \bar{x}_6/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \Delta x_5 \bar{x}_6/4$ $\Delta x_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \bar{x}_5 \Delta x_6/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \Delta x_4 \bar{x}_5 \bar{x}_6/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \Delta x_5 \bar{x}_6/4$ $\Delta x_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \bar{x}_5 \Delta x_6/4$ $\Delta x_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \Delta x_5 \bar{x}_6/4$ $\Delta x_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \bar{x}_5 \Delta x_6/4$ $\Delta x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 \Delta x_5 \Delta x_6/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \Delta x_4 \bar{x}_5 \bar{x}_6/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \bar{x}_4 \Delta x_5 \bar{x}_6/4$ $\bar{x}_1 \Delta x_2 \Delta x_3 \bar{x}_4 \bar{x}_5 \Delta x_6/4$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \Delta x_4 \Delta x_5 \bar{x}_6/4$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \Delta x_4 \bar{x}_5 \Delta x_6/4$ $\bar{x}_1 \Delta x_2 \bar{x}_3 \bar{x}_4 \Delta x_5 \Delta x_6/4$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \Delta x_4 \Delta x_5 \bar{x}_6/4$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \Delta x_4 \bar{x}_5 \Delta x_6/4$ $\bar{x}_1 \bar{x}_2 \Delta x_3 \bar{x}_4 \Delta x_5 \Delta x_6/4$ $\bar{x}_1 \bar{x}_2 \bar{x}_3 \Delta x_4 \Delta x_5 \Delta x_6/4$
			$\Delta x_1 \Delta x_2 \Delta x_3 \Delta x_4 \Delta x_5/16$	$\Delta x_1 \Delta x_2 \Delta x_3 \Delta x_4 \Delta x_5 \bar{x}_6/16$ $\Delta x_1 \Delta x_2 \Delta x_3 \Delta x_4 \bar{x}_5 \Delta x_6/16$ $\Delta x_1 \Delta x_2 \Delta x_3 \bar{x}_4 \Delta x_5 \Delta x_6/16$ $\Delta x_1 \Delta x_2 \bar{x}_3 \Delta x_4 \Delta x_5 \Delta x_6/16$ $\Delta x_1 \bar{x}_2 \Delta x_3 \Delta x_4 \Delta x_5 \Delta x_6/16$ $\bar{x}_1 \Delta x_2 \Delta x_3 \Delta x_4 \Delta x_5 \Delta x_6/16$

TABLE 5

Variance Analysis Model for Two-Variable Revenue

Variable	Variance
Unit Price, p	$\Delta p\bar{q}$
Quantity Sold, q	$\Delta q\bar{p}$
Revenue, $R(p,q)$	$p_a q_a - p_b q_b$

TABLE 6

Variance Analysis Model for Three-Variable Spending

Variable	Variance
Unit Cost, c	$\Delta c\left(\bar{q}\bar{u} + \frac{\Delta q\Delta u}{12}\right)$
Quantity Sold, q	$\Delta q\left(\bar{c}\bar{u} + \frac{\Delta c\Delta u}{12}\right)$
Usage, u	$\Delta u\left(\bar{c}\bar{q} + \frac{\Delta c\Delta q}{12}\right)$
Spending, $S(c,q,u)$	$c_a q_a u_a - c_b q_b u_b$

TABLE 7

Variance Analysis Model for Four-Variable Spending

Variable	Variance
Unit Cost, c	$\Delta c\left(\bar{q}\bar{u}\bar{x} + \frac{\Delta q\Delta u\bar{x} + \Delta q\bar{u}\Delta x + \bar{q}\Delta u\Delta x}{12}\right)$
Quantity Sold, q	$\Delta q\left(\bar{c}\bar{u}\bar{x} + \frac{\Delta c\Delta u\bar{x} + \Delta c\bar{u}\Delta x + \bar{c}\Delta u\Delta x}{12}\right)$
Usage, u	$\Delta u\left(\bar{c}\bar{q}\bar{x} + \frac{\Delta c\Delta q\bar{x} + \Delta c\bar{q}\Delta x + \bar{c}\Delta q\Delta x}{12}\right)$
Exchange Rate, x	$\Delta x\left(\bar{c}\bar{q}\bar{u} + \frac{\Delta c\Delta q\bar{u} + \Delta c\bar{q}\Delta u + \bar{c}\Delta q\Delta u}{12}\right)$
Spending, $S(c,q,u,x)$	$c_a q_a u_a x_a - c_b q_b u_b x_b$

$$
\begin{aligned}
a_1a_2a_3a_4 - b_1b_2b_3b_4 = \frac{1}{8}[&(a_1 - b_1)(a_2 + b_2)(a_3 + b_3)(a_4 + b_4) + \\
&(a_1 + b_1)(a_2 - b_2)(a_3 + b_3)(a_4 + b_4) + \\
&(a_1 + b_1)(a_2 + b_2)(a_3 - b_3)(a_4 + b_4) + \\
&(a_1 + b_1)(a_2 + b_2)(a_3 + b_3)(a_4 - b_4) + \\
&(a_1 - b_1)(a_2 - b_2)(a_3 - b_3)(a_4 + b_4) + \\
&(a_1 - b_1)(a_2 - b_2)(a_3 + b_3)(a_4 - b_4) + \\
&(a_1 - b_1)(a_2 + b_2)(a_3 - b_3)(a_4 - b_4) + \\
&(a_1 + b_1)(a_2 - b_2)(a_3 - b_3)(a_4 - b_4)].
\end{aligned}
$$

The first four terms on the right-hand side of this equation have a single − and the next four terms on the right-hand side of this equation have three −'s in the terms. The key to the proof is to see that all of the terms on the right-hand side of this equation cancel except for the monomials $a_1a_2a_3a_4$ and $b_1b_2b_3b_4$.

SUMMARY

Using two-variable revenue as an example, we demonstrated how the commonly-used variance analysis model is biased in favor of one of its component variables. We discussed the opportunity for improvement by incorporating the concept of responsibility centers. We presented alternative models with the focus being on an n-variable product with zero or n responsibility centers. We supported the proposed models with a mathematical proof showing the difference of a product of n variables can be expressed as simply as a function of averages and differences. Specific revenue and spending models were presented.

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APPENDIX: PROOF OF THEOREM 1

For the purposes of this proof, let $x_{i,1} = b_i$ and $x_{i,2} = a_i$, for $i = 1, 2, \ldots, n$. It is sufficient to show that

$$\prod_{i=1}^{n} x_{i,2} - \prod_{i=1}^{n} x_{i,1} = \sum_{d=1, d\ odd}^{n} \frac{1}{2^{d-1}} \sum_{S \subseteq [n], |S|=d} \prod_{j \in S, k \in S'} (a_j - b_j)(a_k + b_k), \qquad (4)$$

so that the right-hand side of the equation will be written entirely in terms of sums and differences. The result is proven by showing that of all of the monomials resulting by multiplying out the right-hand side of this equation, for example, $a_1 a_2 b_3 a_4 \ldots b_n$, all terms cancel except for $\prod_{i=1}^{n} a_i$ and $\prod_{i=1}^{n} b_i$. For the terms to cancel, there must be an equal number of positive and negative terms comprising the monomial. The number of odd-order subsets of $[n]$ is 2^{n-1}. This can be seen by expanding $(1-1)^n$ by the binomial theorem:

$$(1-1)^n \sum_{i=0}^{n} (-1)^n \binom{n}{i} = 0$$

Separating the negative and positive terms,

$$\sum_{i=0, i\ odd}^{n} \binom{n}{i} = \sum_{i=0, i\ even}^{n} \binom{n}{i}$$

Since

$$\sum_{i=0}^{n} \binom{n}{i} = 2^n$$

there are 2^{n-1} odd-ordered subsets and 2^{n-1} even-ordered subsets of $[n]$.

Now consider an arbitrary monomial resulting in multiplying out the terms on the right-hand side of Equation 4. To show that all terms except $\prod_{i=1}^{n} a_i$ and $\prod_{i=1}^{n} b_i$ cancel, consider the following cases involving a particularly arbitrary monomial other than $\prod_{i=1}^{n} a_i$ or $\prod_{i=1}^{n} b_i$.

Case 1. The number of times that the monomial is *negative* equals the number of odd-order subsets of $[n]$ containing an *odd* number of k-element index sets, which equals the product of the number of *odd*-order subsets of k-element sets and the number of *even*-order subsets of $(n-k)$-element complement sets, which, by the multiplication rule, is

$$2^{k-1} \cdot 2^{n-k-1} = 2^{n-2}.$$

Case 2. The number of times that the monomial is *positive* equals the number of odd- order subsets of $[n]$ containing an *even* number of k-element index sets, which equals the product of the number of *even*-order subsets of k-element sets and the number of *odd* -order subsets of $(n-k)$-element complement sets, which, by the multiplication rule, is

$$2^{k-1} \cdot 2^{n-k-1} = 2^{n-2}.$$

Since there are an equal number of positive and negative terms on any monomial term except $\prod_{i=1}^{n} a_i$ and $\prod_{i=1}^{n} b_i$, they must cancel. All of the 2^{n-1} products involving the monomial $a_1 a_2 \dots a_n$ are positive and all of the 2^{n-1} products involving the monomial $b_1 b_2 \dots b_n$ are negative, which proves the result.

UNDERSTANDING CENTRAL BANK FINANCIAL REPORTING: THE CASE OF THE FEDERAL RESERVE

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ABSTRACT

The increased prominence of central banks and the unprecedented use of unconventional monetary policy tools in recent years has elevated the need to better understand central bank financial reporting. In this paper, the financial reporting for the Central bank of the United States (the FED) is examined. The FED uses a reporting methodology which is analogous to that used in "for profit" accounting. The FED, however, is not a "for-profit" entity, but is instead a unique entity whose purpose, function, structure, and reporting oversight are specifically and uniquely defined by statute. Because of its unique role, the conceptual meaning of the various balance sheet elements the FED reports upon differ markedly from traditional "for-profit" accounting applications. In this paper, these conceptual differences are identified and discussed. A better understanding of these differences can aid investors, regulators, and others, to make investment decisions, especially during times of national and global economic emergency.

INTRODUCTION

Prior research has established that central bank reporting has significant economic implications (Thorbecke, 1997; Crawley, 2015; Meder, 2015; Schwartz et al., 2014). These implications include effects on the cost of capital, capital investment efficiency, effectiveness of government oversight, political costs, and appropriate application of monetary policy. In recent years, all of these implications have arguably increased markedly. That is because central banks have taken an increasingly prominent role in financial markets and economic affairs. As part of this change, aggressive and unprecedented monetary actions have been employed, including massive emergency funding to major financial entities, quantitative easing, operation twist, "helicopter" money, ZIRP and NIRP among others.[1] The unprecedented use of these unconventional monetary

[1] Quantitative easing refers to an unconventional monetary action in which a large amount of newly created money is used to purchase bonds and other financial assets; operation twist is a policy designed to manipulate the yield curve; ZIRP is a policy of setting key interest rates, such as the Fed Funds rate, at zero.
"NIRP is a policy of setting key interest rates, such as interest on bank reserves, below zero. "Helicopter money" is a term that describes the printing of money and distributing it directly to individuals and/or governments.

policy tools increase the need for appropriate understanding of central bank financial reporting, particularly the portions that convey useful information about the use of these tools.

The central bank of the United States (hereafter, “the FED”), because it identifies as a bank, uses a reporting terminology which is analogous to that used in “for profit” accounting. The FED, however, is not a “for-profit” entity. Conversely, it is also distinctly different in structure from other more conventional governmental units and non-profit entities. Because of its unique role, the conceptual meaning of the various balance sheet elements the FED reports upon have distinctive meanings, relative to that of for-profit entities, and/or traditional governmental units and non-profit entities as well. In this paper, these distinctive meanings are identified and discussed.

The major issues discussed in this paper are as follows. First, the FED uses, with little modification, a standard commercial bank balance sheet for its financial reports. This balance sheet consists of three major elements: assets, liabilities, and capital equity. For commercial banks, the purpose of reporting such elements is to inform about the financial position of an entity, including capital contributed and/or generated by commercial operations. They also play an important role in assessing investment risk. In for-profit accounting, the balance sheet also serves as a timing buffer to support accrual-based recognition of “profit”- an information construct which arguably helps shareholders and potential investors in commercial enterprises assess the amount, magnitude, and certainty of future cash flows. In the case of the FED, however, none of these reporting purposes and uses apply.

First, with respect to FED’s financial position, with respect to assets, is economically meaningless in the usual sense. For-profit enterprises, and traditional governmental units and non-profits, each report assets as a means of conveying information about the financial position of the unit or entity. But the Fed can print money, and thus create and/or acquire economic assets, at will. So, assets cannot represent, in any meaningful way, the Fed’s financial position. Similarly, liabilities are a meaningful component of the balance sheet for commercial enterprises as well as traditional governmental units and non-profits. That is because they convey what an entity is committed to and responsible for, in terms of principal repayments. But the obligations of the FED have no due date and are not redeemable for any asset other than additional “notes” and credits issued by the same entity- the FED itself. Clearly then, they are not meaningful as “liabilities” in the sense that would be applied to other entities, be they for profit, non-profit, or even traditional governmental units of various kinds.

Finally, as discussed later in more detail, “capital” has no traditional meaning in the case of the FED. As we will show, “capital” contributions, even when made, are not a significant funding source for the FED. The FED, because it has the power to create money, simply doesn’t need capital funding, and the “capital” that is provided by member banks, carries no risk, or potential for residual profit, but instead yields a stated percentage return to the contributor. In summary, the FED’s governmental affiliation and purpose arguably renders traditional understandings of balance sheet elements, such as assets, liabilities, and capital, economically meaningless, at least in terms of how such elements would be understood within a standard commercial bank reporting structure.

Second, there is the meaning of the term “income” under the for-profit financial reporting the FED utilizes. The FED does not exist to make a profit, as a commercial bank does. Instead, its primary focus is to manage the nation’s money supply and carry out monetary policies on behalf of the US Government. Any seigniorage created through the FED’s monetary activity is incidental to its primary purpose, and, as such, is returned to the US Treasury.[2] US GAAP based “profit” and “capital”, artifacts of the commercial bank reporting model which the FED employs, thus serve little or no purpose when it comes to understanding the monetary policy actions of the central bank. Moreover, they have the potential, if misinterpreted, to even hinder such action. When emergency monetary actions are needed, capital “deficits” may occur, since losses are closed to

[2] The traditional definition of seiniorage is the difference between the value of money and the cost to produce and distribute it. There are numerous other possible definitions. The FED itself uses “net earnings”, less an amount needed to maintain capital surplus at a certain level, as its effective definition. For more discussion on the amount of seigniorage the FED earns, see Neumann (1992).

capital being reported on the FED's balance sheet. Conversely, at the end of a crisis, when it is desirable to restore normal monetary policy and/or reduce excess reserves, recycling of repayments of debt securities held by the FED, write-downs, or even direct asset sales, may be required. In addition, interest rates will likely need to rise to "normal" levels, causing the value of "mark-to-market" paper to fall. Large losses and capital deficits may thus appear, during and/or after a crisis, implying there is a solvency problem. But given its unlimited capacity to create money, the FED cannot be insolvent.

Given the uniqueness of the FED as an institution, and its use of a standard for-profit financial reporting model, it is incumbent upon users to clearly understand Federal Reserve reporting, and interpret terms like "Assets", "Liabilities", "Capital", and "income" in a manner consistent with the FED's purpose, powers granted by statute, governance structure, and mandate. Such an understanding could help In discerning the amount, form, magnitude and, ultimately, the effectiveness, of the monetary policy that is conducted by the FED.

The remaining parts of this paper as follows. In the following section, the unique institutional nature of the FED is identified. Next, the FED's balance sheet is reviewed, including asset specification, liabilities, and the notion of capital, as applied to a quasi-governmental institution like the FED. We then review the concept of income, as it is reported under the FED's commercial accounting structure, and how this relates to the FED's charter and mandate. Next, the notion of monetary finance is introduced, together with reporting issues and needs it introduces, especially when the FED's mission and purpose is broadly expanded, as it has been in recent years. This article ends with a brief discussion of interpretation of the FED's financial reports under the current reporting scheme, including identification of monetary resources provided by the FED, monetary credits given, valuation issues, and determination of seignorage.

THEORY

The FED is distinctive in that it is authorized by the US Government to create and distribute base money into the economy. The traditional purpose of a central bank has been to provide sufficient currency and coin to facilitate economic exchange, to provide liquidity, when necessary, to undercapitalized banks, and to mitigate banking panics by standing in as a "lender of last resort" in times of financial distress. The purpose of the FED and other central banks, however, has expanded over time to include and emphasize public policy objectives, e.g., full employment, a slow and steady rise in the price level of goods and services (low inflation), the mitigation and prevention of economic depression, military funding in times of war, and so forth.

The FED, in its charter, was given three primary objectives to focus on when conducting monetary policy: maximizing employment, stabilizing prices, and moderating long-term interest rates. The first two are of primary importance and are often labeled as the FED's "dual mandate". To meet this mandate, a target is set for the Fed funds rate, the overnight interest rate banks charge each other to borrow reserves they hold at the FED. The FED typically effects changes in this rate through temporary positions (e.g., reverse repo transactions) that affect the supply of bank reserves and thereby the interbank rate charged for the use of such reserves.

When conditions are severe enough, however, conventional monetary policy mechanisms may be compromised. For example, if nominal interest rates are at or near zero, or below, cutting interbank rates further may not be possible. Similarly, if the monetary policy transmission process is significantly impaired, conventional monetary policy tools may be rendered ineffective. In such a case, unconventional actions may be necessary, e.g., (a) purchasing a greater proportion of longer-term securities, (b) buying much larger quantities of assets, or (c) monetising unconventional assets such as stocks and unsecured commercial paper.[3] In all cases, the unconventional measures that would be applied are likely to go well beyond manipulation of short-term interbank interest rates.

A related, and even more aggressive form of unconventional monetary policy is monetary financing on the part of the central bank. Such financing may be required during times of financial distress, economic malaise and/or extreme financial need. It has been used by governments in

[3] See Bernanke and Reinhart (2004).

various countries around the world (Turner, 2015). During the two world wars, for example, it was common for governments to harness the help of central banks to help fund military expenses. It has also been used by governments to escape economic depression with minimal damage.

Monetary financing can take several forms and, in so doing, serve a variety of public policy purposes. For example, a central bank can directly re-capitalize a failed depository institution through purchase of troubled assets at prices that are far higher than their actual market value at the time of the crisis. This form of monetary financing has been used many times by central banks in their role as lenders of last resort. To the extent the purchase of distressed assets are made for greater than fair value, the central bank has, in effect, provided emergency monetary financing.

Monetary financing can also be provided to relief economic stress during periods of economic crisis (Turner, 2015). Although such relief is not permitted to be directly provided by the FED under US statutes, the FED can ramp up the purchase of treasury bonds issued to cover excess funding needed by Treasury to provide direct relief to the public during times of such extreme stress. This kind of monetary policy action occurred very recently, in 2020, in response to the Covid crisis and the economic shutdown it precipitated.

Liabilities

The currency the FED creates is, in form, a note and, as such, is reported as an accounting "liability". This practice is rooted in the long-standing use of bank notes for money in the economy. When notes are issued by a commercial bank and/or are redeemable for real assets, such as gold, the notion that such notes are liabilities is more defensible. In the case of the FED, the original Federal Reserve Act of 1914 required that all Federal Reserve paper be 100% backed by, and redeemable for, gold. Such paper was, arguably, rightfully classified as a liability in the sense that it carried an embedded option to be redeemed for gold. This embedded option clearly implies the potential for a future economic sacrifice on the part of the FED- a liability which increased, in the probabilistic sense, with the issuance of each reserve note.

The original restriction was quickly changed, however, in 1917, to 40% backing by gold, and 60% acceptable commercial paper. Later, in reaction to the great depression, the US went off the "gold standard" domestically but stayed on for international payments. After the end of World War II, the Bretton Woods system came into being. Under this system, currencies around the world were "pegged" to the US dollar at a fixed rate of exchange. The dollar itself remained convertible to gold, and, as such, held equal footing with gold for use as a reserve currency by other banks around the world. The gold convertibility feature completely ended in 1971. Subsequently, the value of most currencies then "floated" as foreign exchange markets repriced continuously the value of each currency based on the conditions of supply and demand, inflation differentials, and other factors[4] At this point US money became a fiat currency. The convertibility attribute that justified classification of FED notes as an accounting liability no longer applied but *FED accounting did not change.*

Today, even though FED notes are fiat in nature (i.e., not redeemable for anything other than more notes), have no due date, and no interest due on the notes, they are still accounted for as liabilities on the FED's balance sheet. Moreover, FED notes, in aggregate, and across time, are not redeemed. The base money supply has instead been growing, almost without interruption, ever since the FED was created.

When FED notes are accounted for as liabilities, they are not depicted for what they are - an asset created and provided by the FED, but instead are reported as an economic sacrifice the central bank will be called on, in the future, to make. But being fiat currency, that day will never come.

[4] There were a few exceptions. Some smaller countries did peg their currencies to the currency of economically larger countries.

Asset Valuation

In the course of the FED's money creating activities, bonds are acquired and duly recorded at whatever amount of money the FED distributed for them. These securities, especially during times of crisis, are not necessarily acquired at "market value". Even when they are acquired on the open market through a competitive bidding process, the very purpose of such acquisition is undertaken to affect changes in interest rates or shifts in the interest rate structure of the credit markets. The FED is not just another arms-length, price-taking buyer of securities on the open market. The whole point of bond purchases is to manage prices and yields down or up and otherwise incentivize changes in the supply and demand of credit- all to achieve the FED's primary mandates - "low" inflation and "full" employment.[5] All of this suggests that the reported valuations of debt securities acquired by the FED should be taken with a grain of salt. As mentioned earlier, FED assets are not always marked to market.[6] Even if they were, however, such information can serve no purpose, for it plays no role in monetary policy.

The Concept of "Capital"

The whole issue of whether central bank capital impacts, in any way, monetary policy has been debated for some time. There is some evidence that a weak balance sheet can influence the conduct of monetary policy (Adler et al., 2016). The effects, however, seem to be very much non-linear, and given the dollar's role as the world's reserve currency, it is debatable what the FED's situation is in that regard.

Part of the conflict surrounding this debate arguably derives from the misspecification of "capital" in central bank financial reporting. The problem is not how internally generated "capital" is measured as any revenue and cost misspecifications would necessarily be passed on to the Treasury, in the case of the FED, via offsetting adjustments to transferable seigniorage. The problem is instead, the recognition of capital itself as a reporting concept. The FED is a

[5] Current targets for the mandates are about 2% inflation and unemployment of approximately 4.6%.

[6] This policy is partly the result of accounting changes arising during the financial crisis, which gave financial institutions considerable leeway in the classification of financial instruments, in essence, empowering them to avoid marking distressed assets to market, thereby eroding tier 1 capital and hampering normalization of lending activity.

government authorized and empowered entity, best characterized as an agent and affiliate of that Government. What can “capital”, a commercial balance sheet concept, mean for such an entity?

One standard attribute that indicates the existence of capital is the presence of “control” on the part of a given stakeholder. But the FED’s monetary policy decisions are not approved by any private cache of capital providers nor by any officials elected by same. The FED is instead governed by a structure imposed by the Federal Reserve Act itself. There are seven members appointed by the President of the United States and confirmed by the Senate. The President also designates, and the Senate confirms, two members of the Board to serve as Chairman and Vice Chairman. The primary responsibility of the Board members is the formulation of monetary policy. The seven Board members also constitute a majority of the 12-member Federal Open Market Committee, which makes the key decisions affecting the cost and availability of money and credit in the economy. The other five members of the FOMC are Reserve Bank presidents, one of whom is the president of the Federal Reserve Bank of New York. The other Bank presidents serve one-year terms on a rotating basis. The various Federal Reserve Banks, in particular, New York, do participate in some governance of monetary actions by the FED, via their role on the open market committee, but the power they have is a minority power, and capital providers of these “banks” themselves have no governance role.

The question thus arises: if the FED’s “capital providers” provide no direct governance or oversight, as common stockholders might, via their voting power, who does? Although officially “autonomous”, in terms of its day-to-day operations, the FED is subject, by statute, to broad oversight by the Congress, and the US Government, which has the power to change the FED’s responsibilities by altering appropriate laws and statutes. But neither the Congress, nor any other part of the US government, holds any capital position in the FED. Instead, the 12 regional Federal Reserve Banks, which were established by the Congress as the operating arms of the nation's central banking system, issue shares of “stock” to member banks. However, owning Federal Reserve Bank stock is not at all like capital equity in the commercial sense. The Reserve Banks are not operated for profit, and ownership of a certain amount of “stock” by member banks is, by law, a condition of membership in the System. The “stock” cannot be sold, traded, or pledged as security for a loan.

What about risk and reward? The only reward to capital equity recognized by the FED is that stockholders of the FED (member banks) do receive “dividends” which are, by statute, paid to at a maximum rate of 6 percent, determined partly as a function of each member bank's total assets. There is, however, no risk associated with these cash flows, or with the value of the member banks’ capital interest itself. The FED’s operating costs, and any investment losses, are absorbed by seigniorage, both current, and future, and whatever is not, could easily be covered by the FED’s power to create money at will. On the other hand, there is also no reward beyond the “dividend”- since all other seigniorage is passed back to Treasury each year. In light of these facts, it becomes obvious that “capital stock” in the FED is more analogous to interest on fixed non-subordinated debt of extremely long maturity. The only kind of private capital that might be somewhat analogous to FED capital is that of nonparticipating, cumulative preferred stock. Here, however, there is at least the risk that a dividend will not be paid. Such risk does not exist with FED stock, as is detailed next.

In conclusion, given the lack of control by member banks (who are the so-called “capital” providers), the lack of any substantive risk-reward structure for those capital providers, and the lack of any meaningful concept of a residual equity interest, the reporting concept of “capital” necessarily takes on a very different character under the FED’s current financial reporting framework.

Income

A feature of the Federal Reserve Act is that the FED is not permitted to retain seigniorage but is instead required to transfer it back to the Treasury each year.[7] Seigniorage, however, is not

[7] Presumably to act as a buffer, the FED is authorized to retain a small amount of seigniorage equal to the amount of capitalization provided by member banks.

"profit" in the usual commercial sense. That is because seigniorage is not created through a business operation aimed at generating economic returns. The FED, however, uses accrual-based accounting in its computation of seigniorage, an approach that, under normal conditions, arguably allows for the determination of a reasonable amount to return to the Treasury each period, even if it does not map precisely to cash flow engendered by monetary activity.

When unconventional monetary policies are invoked, however, the accrual based "income" concept in FED reporting becomes quite troublesome. First, there is no accounting for funding flows, transient and otherwise, which is the real output of monetary action. The lack of a focus on funding flows arguably weakens support for the oversight function, not to mention public transparency. For example, the FED, in the recent financial crisis, resorted to various "simulative" monetary actions, including the use of "facilities" such as Term Auctions, Term Securities Lending, Primary Dealer credit, and commercial paper funding; direct funding to institutions; extensive use of reverse repo transactions, coupled with payments on large excess reserve balances to manage the supply of credit influencing interbank rates; and numerous other "transient" forms of activity. Because these transactions are supposedly "transient" in nature, they are not readily detectable by the FED's financial reporting system, modeled as it is on an accrual-based "income" measurement for an institution rather than explicit documentation of monetary actions that have been taken by the central bank.

Second, because there is little buffer from retained "profits", and almost no capital, relative to the size of monetary activity, "losses" arising from the conduct of unconventional monetary policy may appear to create large capital deficits on the FED's balance sheet. Such losses must be creatively "hidden", through (a) transient mechanisms and facilities (discussed earlier), (b) advance provisioning of future expected "surpluses" (see below), and/or (c) other means which necessarily obscure the "information" now provided under the current reporting model.

The prospect of capital deficits arising, particularly in times when emergency assistance is needed, has raised questions about central bank risk, in particular, whether central banks, when confronted with such risk, are adequately capitalized.[8] The FED's bond portfolio does experience interest rate and default risk. Without retained earnings, little or no provision for potential losses is established - debt to capital ratios typically exceed 50. Thus, the threat of a condition of negative equity exists under the commercial bank reporting model the FED employs. To cope with this problem, the FED, if it must, is authorized to capitalize *future* expected surpluses to the extent necessary to rebuild reported "capital" to minimum required levels. If a commercial enterprise were to use such arcane accounting, representational faithfulness would entirely fail, and a qualified audit report issued.

Monetary Financing

Monetary financing is particularly problematic under the current FED financial reporting model. First, as discussed earlier, and as evidenced in the GAO report, some forms of monetary provisioning, in particular those that are "transient", might not be recognized at all under the current reporting model. Second, with respect to income recognition, monetary financing, in some cases, might require the recognition of a large charge in an amount equal to the amount of the monetary contribution. In each case there would be a transfer of base money to another entity, but there would be something less valuable (or even nothing) received in exchange. Because the FED, as part of its authorization, can essentially retain no profit, but must transfer back to Treasury most excess of revenue over expense, there is almost no retained earnings, and thus any "contribution expense", to the extent it was recognized, and exceeded the FED's capital, would create negative capital on the FED's balance sheet. For any significant amount of monetary financing, this negative capital would be large, thus, and quite falsely, without interpretation, portray a condition of insolvency on the part of the central bank.

[8] A number of researchers have raised this issue, including Archer and Moser-Boehm (2013); Caruana (2013), and Schwartz (2016).

To summarize, the current accounting and financial reporting model used by the FED is, with few modifications, the standard commercial bank accounting model. The use of such a model by the nation's central bank arguably leads to a number of challenges with respect to the interpretation of the FED's financial reporting. The major challenges concerning interpretation of FED financial reporting are summarized in Tables 1a and 1b. Table 1a summarizes typical balance sheet elements the FED financial reporting utilizes, including their conceptual definitions, items commonly included in FED financial reports, and the misspecifications arising from a traditional interpretation of these elements.

Insert Table 1a about here

Table 1b provides the same detail for "income" related elements.

Insert Table 1b about here

Interpretation

Although it does not conform to standard definitions of accounting elements when applied to the FED, the commercial bank reporting framework still provides a great deal of useful information to the public about monetary policy activity conducted by the Central Bank. This information may be described using the following model:

$$\text{Monetary Resources} = \text{Monetary Credits} \tag{1}$$

The FED provides monetary resources to depository institutions, governments, and the economic system at large. The provision of monetary resources, i.e., base money, into the economy is the key tool by which the FED carries out its primary function of fulfilling mandated goals and objectives. The main way this is accomplished is through purchases of bills, bonds, and other financial instruments in open market operations (see Figure 1).

Insert Figure 1 about here

This purchasing is essentially a swap, or exchange, of zero, or very low interest-yielding, paper (or bank reserve), for interest-bearing government paper. This "swapping" is detectable via the FED balance sheet, as part of the assets reported by the Central Bank. Changes in reported assets that are acquired by the FED through open market activity reflect the extent of this “swapping”. The swapping of non-interest (or very low interest) paper, primarily for government bills and bonds (that usually earn slightly higher interest than zero or low interest bank reserves and currency) may impact macroeconomic conditions by (a) lowering interest rates, and (b) raising financial asset prices as holders of zero (or very low interest reserves) are now further incented to obtain higher yield through exchange of zero or very low interest monetary credits.

“Monetary credits”, are the actual monetary form of the resources conveyed in the swap. They include the actual amount of currency, reserve credits, and other credits created by the FED. Reported FED liabilities include these “Monetary credits” along with a number of relatively smaller minor items, including other accounting credits, any transferable seigniorage that has not yet been transferred (see equation 2, below), credits to government units that are due, and contributions made to the FED by member banks as part of the contractual obligations associated with Federal Reserve membership. As discussed earlier, these contributions are essentially a restricted form of bank reserves embedded with a fixed cash flow claim.[9]

Valuation

Under US GAAP, financial assets are typically marked to market, with any associated gains or losses charged to income in the case of financial intermediaries such as banks. “Fair value” accounting, however, including the recognition of unrealized gains and losses on financial assets, has little meaning with respect to monetary policy actions conducted by the FED. That is because changes in the fair value of monetized assets are strictly an incidental effect and so have no informational relevancy with respect to the FED’s mission or purpose. What matters, informationally, is not the value of monetized assets the FED holds, but the amount of *monetary resources provided* when such assets are acquired, as part of the swapping discussed above. For that purpose, only historical exchange amounts matter.

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[9] The whole idea of member capital equity and dividends is, in fact, confusing, and should, perhaps be considered by public policy makers for elimination. The FED, with unlimited power to create money, has no reason to raise private equity capital, as such capital serves no purpose, either in risk-absorption (since there is no risk), the providing of operating funds, or in governance (since the FED is governed by a structure established by statute, not voting rights). The dividend is arguably not a dividend, but instead a contribution, paid to member banks, in exchange for which the public receives dubious benefit.

Seigniorage

The FED is required, by statute, to refund to the Treasury, each year, any excess of funds received over funds paid out. The transfers are made weekly. The purpose of these transfers is to remove at least 90% of all seigniorage generated by the central bank. Although currently computed on an accrual basis, seigniorage could be reported on a modified accrual, or even cash, basis. Under such a basis, transferable seigniorage may be computed as follows:

$$\begin{aligned}\text{Transferable Seigniorage} = {} & \text{Receipts} - \text{Expenditures} + \text{Assessments} \\ & - \text{Payments on Reserves} - \text{FED Cash Provision} \\ & + \text{monetary gains} - \text{chargeable monetary losses} \quad (2)\end{aligned}$$

Transferable Seniorage	=	The amount of net cash flow, resultant from monetary policy activity, that is available for transfer back to Treasury each period.
Receipts	=	cash inflows from coupons on loans held by the FED, discounts earned on acceptances, interest payments on treasuries, fed agency paper and GSE debt securities (whether held in the FED's own accounts or as part of open market operations), earnings on bills, revenue bonds and warrants, interest on foreign exchange holdings, income for services, charges for overdrafts, cash inflow from the sales of operational assets, and so forth
Expenditures	=	outflows associated with FED operations, including labor, purchase of fixed assets, pension costs, and so forth.
Assessments	=	amounts the current statute requires that the member banks pay to the FED for board expenses, the cost of printing and issuing currency, the Board of Consumer Finance Protection, and the Office of Financial Research
Payments on Reserves	=	amounts the FED pays to depositary institutions (both domestic and foreign) on excess reserve balances held at the FED.[10]
FED Cash Provision	=	any amount taken out of seigniorage that is needed to restore the required "capital" buffer the FED must maintain by statute.[11]
Monetary gains	=	when monetized assets are sold back to depositary institutions, or on the open market, for an amount that was greater than the cost when purchased. Such gains amount to a direct form of seigniorage realized by the central bank as it takes monetary actions.

[10] These payments are currently labeled as "interest". They are a recent innovation designed to prevent large amounts of excess reserves from "leaking" into the credit markets as interest rates rise, thus hampering the efficient conduct of monetary policy.

[11] Given its unlimited power to create money, there is arguably no need for such a buffer in the case of the FED.

Chargeable monetary loses	=	In difficult economic conditions, or when the FED is involved as a liquidity provider, particularly as lender of last resort, assets may be monetized at amounts that far exceed their true fair value at that time. If the assets are subsequently sold for an amount significantly below cost, or they are determined, immediately, or later, to be permanently impaired, relative to the acquired value, in effect, the FED has provided unconventional monetary financing to the market for the amount of the difference received, or the write-down in cases of impairment or default.

Notably, the FED now produces a “Statement of Operations” that, although accrual based, is otherwise similar to Equation (2).

CONCLUSION

The central bank of the United States, the Federal Reserve, has grown considerably in size, scope, responsibility, and power since it began early last century. Yet its accounting and financial reporting system remains anchored in the roots of its beginnings - that of a bank, primarily serving other commercial banks, for the purpose of improving liquidity, coordinating bank activity, and acting, if necessary, as a lender of last resort to those banks.

The role of the FED today has been greatly expanded to include the achievement of government mandated goals and directives, in particular, to stabilize prices and achieve full employment in the economy. When the FED’s financial reports are analyzed in light of these expanded purposes, with traditional balance sheet and income statement elements reinterpreted to reflect the FED’s uniqueness, relative that of a for-profit bank, or more conventional governmental non-profit entity, the relevancy and meaningfulness of FED accounting and financial reporting, in the context of current times and circumstances, arguably becomes clearer.

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Table 1a

Conceptual Analysis of Current FED Accounting Framework-Balance Sheet

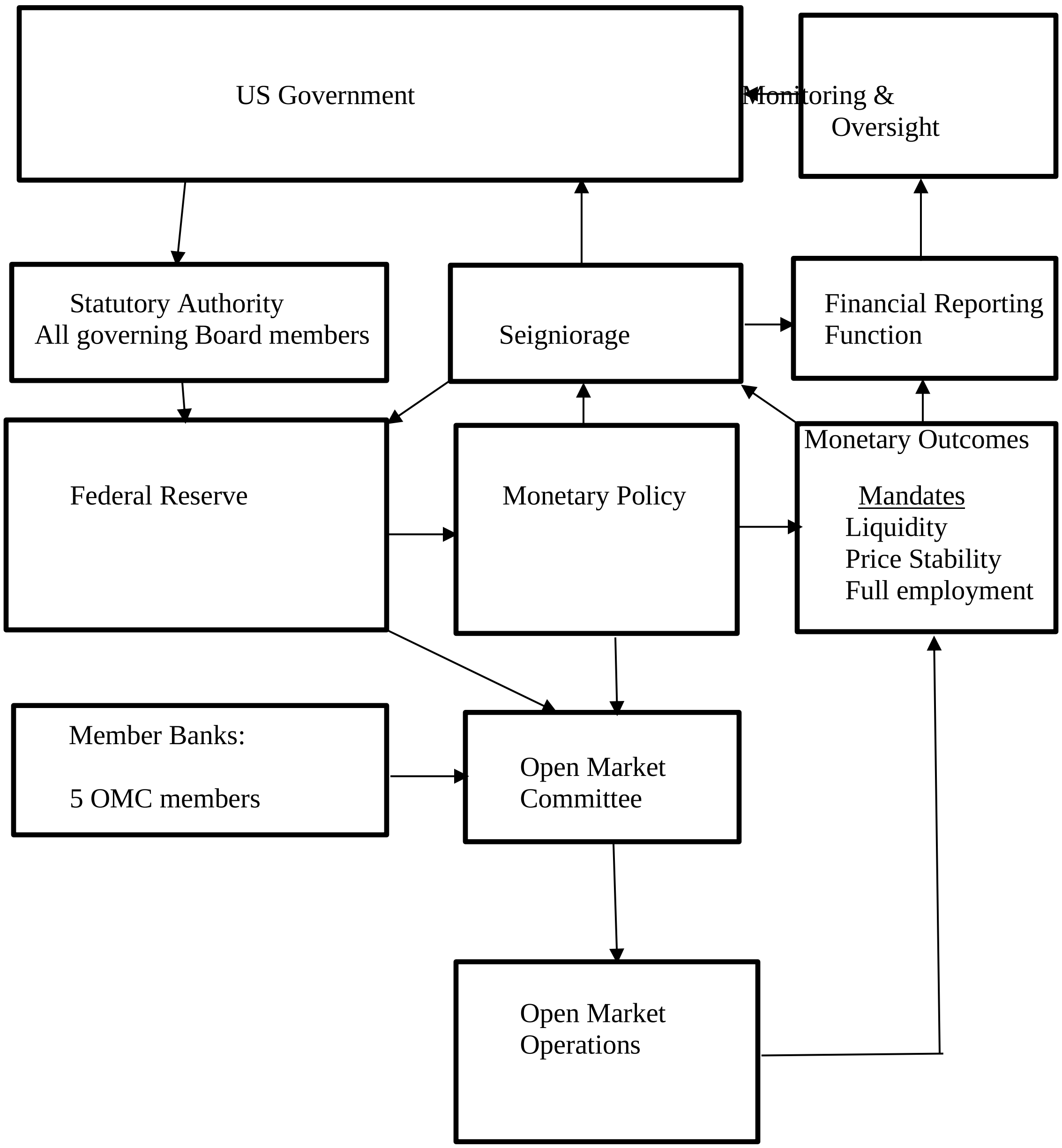
Reporting Element	Conceptual Definition	Current FED model	Valuation Basis	Limitations
Assets	Probable future economic benefits obtained or controlled by a particular entity as a result of past transactions or events	Includes coin, prepaid items, loans to depository institutions, acceptances, federal agency obligations, US Treasuries, land, buildings, machinery and equipment, furniture, etc.	Mix of historical cost, with adjustments for amortization and depreciation; and fair value	Does not focus on monetary activity. Does not focus on the amount of monetary resources deployed. Does not report monetary financing activity.
Liabilities	Probable future sacrifices of economic benefits arising from present obligations of a particular entity to transfer assets or provide services to other entities as a result of past transactions or events	Includes federal reserve notes, deposits from depository institutions, the Treasury, foreign entities, etc., operating accruals, pension obligations, Payables, deferred credits, reverse repos, etc.	Mostly historical cost, with standard US GAAP expense estimations, recognition of operating and financial accruals, pension obligations, etc.	Follows form not substance; Reports notes with no due date, and deposits that can be satisfied with fiat currency as liabilities. Does not account for all monetary credits. Does not focus on monetary activity.
Capital Equity	A residual interest in the net assets of the entity	Includes capital paid in, surplus (restricted to be the same amount as capital paid-in) and undistributed net income.	Permanent, or real, amounts are established by statute.	The notion of “equity” does not apply. Member banks hold no residual interest. No risk and reward associated with capital. No tie-in to statutory compliance

Table 1b

Conceptual Analysis of Current FED Accounting Framework -Income Statement

Reporting Element	Conceptual Definition	Current FED model	Limitations
Revenue	Inflows or other enhancements of assets of an entity or settlements of its liabilities (or a combination of both) during a period of delivering or producing goods, rendering services, or other activities that constitute the entity's ongoing major or central operations.	Recognizes revenue when "earned" and "realizable" in accordance with standard practice for commercial banks under US GAAP. Non-SOMA assets classified as trading securities may be written up, and associated gains reported.	Since there is no profit mandate, revenue data is not decision-useful, i.e., it doesn't map to any FED mandate, other than computation of transferable seigniorage. However, there is no compliance reason why seigniorage should be based on accrual concepts.
Expenses	Outflows or other using up of assets or incurrences of liabilities (or a combination of both) during a period from delivering or producing goods, rendering services, or carrying out other activities that constitute the entity's major or central operations.	Generally follow standard US GAAP accrual rules, reporting expenses as incurred. Losses for impairments, Fair value write-downs for trading securities, expenses for pension, other payroll costs, etc.	Same problem as for revenues. The lack of a profit mandate greatly weakens any utility in reporting of accruals related to this institution's expenditures.
Assessments	No US GAAP analog	Added to "current net income" to arrive at "Net income available for distribution".	Costs for board expenses, consumer financial protection, currency and minting are not revenue, but expenditures related to the conduct of monetary policy.
Deductions	No US GAAP analog	Subtracted from "Net Income Available for Distribution" to arrive at "undistributed net income".	Misclassification issues. For example, "Interest paid on federal reserve notes" is reported here, but it is really a form of monetary financing.

Figure 1
The Role of Financial Reporting in
The Conduct of Monetary Policy



WHAT HAPPENS TO IPRD AFTER CAPITALIZATION?

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WHAT HAPPENS TO IPRD AFTER CAPITALIZATION?

ABSTRACT

We investigate what happens to in-process research and development cost (IPRD) after acquirers capitalize it in acquisitions completed during 2009-2018. IPRD is the value allocated to incomplete research and development projects in acquisitions. SFAS 141 (R) enables us to trace what happens to IPRD for 74 out of 89 acquisitions (83.1%) with significant IPRD. We find that, on average, companies write off a similar percentage of the IPRD as impaired compared to the percentage transferred to completed technology. Further, we find mixed evidence on whether acquiring companies value IPRD accurately. IPRD acquired has a positive association with the percentage transferred to completed technology but does not have a negative association with the percentage written off. Overall, we find that with the changes in the accounting rule for IPRD, financial statements provide information on the future success or failure of IPRD. This descriptive study is the first to show the frequency of success and failure in acquired IPRD in mergers and acquisitions.

INTRODUCTION

We investigate what happens to in-process research and development cost (IPRD) after acquirers capitalize it in acquisitions completed during 2009 - 2018. IPRD is the value allocated to incomplete research and development projects in acquisitions. Accounting for IPRD changed with SFAS 141 (R), which requires that companies report the purchase price allocated to IPRD as an indefinite-lived intangible asset until the completion or abandonment of the associated research and development efforts (SFAS 141R para 66). Under the previous accounting rules for IPRD (SFAS 2 and FASB Interpretation 4), acquiring companies expensed IPRD in the acquisition year.[1]

SFAS 141 (R) enables financial statement users to trace the success or failure of IPRD in a firm's financial statements. If in future years a company successfully completes IPRD, it will transfer the cost to completed technology, a definite-life intangible. Alternatively, if the company abandons the IPRD, it will write off the cost as an impairment loss.[2] The company

[1] The accounting rules for IPRD have not changed since SFAS 141 (R). The current accounting rules for IPRD acquired in a business combination are stated in FASB ASC paragraph 350-30-35-17A. The IPRD accounting rule change only affects IPRD acquired in a business combination; IPRD that is separately acquired is still expensed under SFAS 141 (R) paragraph 2 and FASB ASC paragraph 730-10-25-2c.

[2] As suggested by the reviewer, abandonment of the IPRD project may be related to a change in strategy rather than a failure of the IPRD project. In a later section we discuss what companies disclose in their notes to the financial statements regarding IPRD impairment.

could also sell its IPRD separately, or another firm could acquire the company, including its IPRD. If the company continues to work on the IPRD project, it will continue to report the cost in the same intangible asset account. Finally, the company may decide not to separately report the IPRD or changes in it because of its small magnitude.

Our research extends previous IPRD and R&D literature in four ways. First, IPRD is the earliest point in the R&D process at which a company recognizes an asset. It provides a unique opportunity to examine how management uses its increased discretion to choose when to report IPRD as a success or failure compared to when management had to immediately expense it. Management can use their increased discretion strategically or to disclose private information about the IPRD project. Second, our descriptive paper is the first to provide evidence on the success rate of individual IPRD projects. Previous research provides evidence on future cash flow and earnings effects of R&D and IPRD on a company (Lev and Sougiannis 1996; Deng and Lev 2006) but has not provided information on the success rate of individual IPRD projects.

Third, our research provides additional evidence on the accuracy of IPRD valuations. If IPRD valuations are accurate, we expect that IPRD will have a positive (negative) association with transfers to completed technology (impairments). Dowdell, Lim, and Press (2009) find that IPRD valuations after 1998 are consistent with the extent of the target's R&D activity. Landsman, Liss, and Sievers (2021) provide evidence on the accuracy of IPRD valuations since the capital market prices the acquired IPRD.

Fourth, we provide feedback on the change in the IPRD accounting rule. Under the old rule of expensing IPRD, financial statements did not provide information on what happens to IPRD after the acquisition. However, the old rule required the disclosure of IPRD (SFAS 141 para 51 (g)). With the rule change, SFAS 141 (R) does not require companies to disclose capitalized IPRD as part of the acquisition or to report changes in and remaining capitalized IPRD in subsequent years. Consequently, companies may disclose the future success or failure of IPRD in their financial statements. Still, companies may not report future activity in IPRD due to its immateriality. Chung, Hillegeist, Park, and Wynn (2019) report that SFAS 141 (R) did not affect information asymmetry for IPRD acquirers. While their study focuses on the acquisition year, we focus on subsequent years when companies either complete or abandon IPRD. Kwon and Wang (2020) also investigate the effect of SFAS 141 (R), and they report in their value relevance tests that investors shift valuation weights from earnings to book value after SFAS 141 (R), especially for mergers and acquisitions with higher intangibles.

We determined what happened to IPRD for 74 out of 89 acquisitions (83.1%) with significant IPRD (IPRD greater than five percent of the acquiring company's total assets). Consequently, we find to a large degree that the financial statements disclose what happens to significant IPRD. Further, we find that acquiring companies write off a similar proportion of IPRD compared to the proportion they transfer to completed technology. Across all acquisitions, on average, companies wrote off IPRD as impaired of 28.5%, which slightly exceeded the 24.2% of IPRD that companies transferred to completed technology (Table 4). For 46 acquisitions with at least five years of information available, on average, firms wrote off as impaired 32.9% and transferred 34.7% of IPRD to completed technology (Panel B of Table 8).

We provide mixed evidence on whether acquirers properly value IPRD based on what happens to it. For the 36 acquisitions with IPRD transferred out of the account, IPRD has a weak positive association with the percentage transferred to completed technology (Table 6). For acquisitions with at least five years of information, we find that acquired IPRD has a positive association with completed IPRD and a negative association with incomplete IPRD (Panel B of Table 9). However, we consistently find an insignificant association between acquired IPRD and written-off IPRD.

Finally, when we could not determine what happened to the IPRD acquired by companies, we find that companies report more details on IPRD impairment compared to transfers to completed technology. This observation suggests that companies prefer not to voluntarily disclose successful IPRD transfers, perhaps to keep their competitive advantage over their rivals (Harris 1998).

We organize our paper as follows. We discuss prior research in the next section, followed by our sample selection process. We present results in the subsequent section, and concluding remarks follow in the last section.

PRIOR RESEARCH

Figure 1 presents a timeline for a company with an in-house R&D project. The timeline starts with R&D expenditures. If the R&D project fails, the required expensing of the R&D costs over the history of the project appears justified. Alternatively, if the company successfully completes the in-house R&D project, then the company will expense the costs to complete the project and will consequently not report a completed technology asset on their balance sheet. The company will have higher revenues in the future thanks to the completed technology but will have no R&D costs to match against them. Thus, the conservative accounting treatment of in-house R&D projects disturbs the revenue/expense matching. Some researchers attribute the temporal decline in value relevance of financial statements to the mandatory expensing rule on self-created intangibles such as completed technology with R&D expenditures (Lev 2019; Appleton et al. 2023).

Prior research provides evidence on the success or failure of R&D projects and the benefits of R&D capital. Lev and Sougiannis (1996) document that at least some of the R&D projects are successful. They find that one dollar of research and development cost (R&D) increases future undiscounted earnings by $1.66 to $2.63 over a five- to nine-year period, depending on the industry. Wong, Siah, and Lo (2019) document evidence on the success of R&D projects in the pharmaceutical industry by estimating that 13.8% of all drug development programs eventually lead to approval. Khan (2014, p.25) reports that, on average, it takes about 15 years to obtain FDA approval and the rights to market a drug, with the majority of that time dedicated to clinical trials. Sanford and Yang (2022) show that firms with high R&D capital expand (contract) capital investment more aggressively in response to the present value of growth option news (uncertainty) shocks. Their finding suggests that R&D capital provides real growth options and managers exercise those options by investing in physical capital when they receive good news.

Figure 2 presents the situation in which a company works on an R&D project before its acquisition by another business. If the project has initial success, then part of the value of the acquired company will be IPRD. Through 2008, acquiring companies recognized IPRD as part of the acquisition but then immediately expensed it, consistent with the handling of in-house R&D in Figure 1. Deng and Lev (2006) document that even though a company initially expenses IPRD, the costs have a positive relationship to cash flows in the three years after the acquisition. Their results provide evidence that some of the acquired R&D projects are successful. Starting in 2009, the acquiring company records the IPRD as an intangible asset based on SFAS 141 (R). After the acquisition, if the IPRD project succeeds, the acquiring company transfers the IPRD to completed technology and then amortizes it to expense over its useful life. Alternatively, if the IPRD project fails, the company writes off the IPRD as an impairment loss.

U.S. GAAP recognizes R&D costs as assets in three situations. First, companies recognize completed technology as intangible assets when they purchase these assets, or when they acquire a business with completed technology assets. Second, companies recognize software development costs as an intangible asset once they reach the technological feasibility stage with the software. Third, as discussed above, starting in 2009, companies recognize IPRD as an intangible asset when they acquire a business with incomplete R&D projects. The third situation recognizes an R&D asset earliest in the technology development process.

Accounting for IPRD shares some similarities and differences with accounting for software development costs. Prior to SFAS No. 86 (FASB 1985), firms expensed software development costs like they expensed IPRD before 2009. Starting in 1986, companies capitalized software development costs once a project achieved technological feasibility and subsequently amortized them. The accounting rules for software development costs resemble the rules for IPRD starting in 2009 except that IPRD, when acquired, may not have reached technological feasibility. An acquiring company amortizes the capitalized IPRD once it successfully completes the R&D project. Acquirers must capitalize all IPRD acquired in business combinations. In contrast, not all companies capitalize software development costs. As discussed in Aboody and Lev (1998 fn. 12), software companies can easily justify immediate expensing.[3]

[3] With both IPRD and software development costs, R&D costs before the acquisition/technological feasibility are expensed. Companies capitalize software development costs after technological feasibility but expense ongoing R&D related to IPRD projects after the acquisition.

Two studies investigate the capital market effects of capitalizing software development costs. Mohd (2005) finds that information asymmetry decreases for software firms compared to other high-tech firms. Additionally, Mohd (2005) finds that, among software companies, information asymmetry is lower for firms that capitalize software development costs compared to firms who expense them. Aboody and Lev (1998) find positive associations between annually capitalized development costs and stock returns, cumulative software asset and stock prices, and software capitalization data and subsequent reported earnings. They also find a positive association between development costs fully expensed by firms and subsequent stock returns.

Four studies provide evidence on the effects of recording R&D intangible assets on the balance sheet. Kimbrough (2007) finds that target pre-merger stock prices reflect R&D capital better when target companies recognize completed technology intangible assets in their pre-merger balance sheets. Additionally, Dowdell, Kimbrough, and Lim (2022) find a similar result for IPRD recognized on target company pre-merger balance sheets. In contrast, Chung et al. (2019), using a difference-in-difference research design with treatment versus control firms and pre- versus post-SFAS 141 (R) periods, find that a company's recording of IPRD on the balance sheet does not reduce information asymmetry.[4] Hsieh, Wu, and Wu (2016) document a positive association between future IPRD impairment and IPRD as a percentage of the acquisition price and acquirer market to book but a negative association with the acquisition-year change in R&D expense, number of acquisitions, and size of the acquirer.

Recognition of IPRD as an intangible asset is the only situation in which a company could disclose the success or failure of an R&D project in its financial statements. We investigate whether companies report the success or failure of IPRD in their financial statements. While the expensed IPRD shows up one time only on the income statement at the point of acquiring the target firm, the capitalized IPRD shows up repeatedly on the balance sheet post-acquisition. This change in the information set available to investors may help to extend the time horizon of investors from a short-term focus on meeting or beating earnings targets to a long-term focus on value creation investments. Consistent with this conjecture, Oswald,

[4] Baker, Larcker, and Wang (2022) show that difference-in-difference estimators can result in Type-I and Type-II errors due to the bias of regression estimators.

Simpson, and Zarowin (2022) report that the switch to capitalization of development costs in the U.K. has reduced the bid-ask spreads and increased R&D expenditure (i.e., the real effect of accounting treatment on R&D development costs).

SAMPLE SELECTION

We select our sample from 2009 through 2018 acquisitions using the purchase price allocation (PPA) data from Houlihan and Lokey.[5] Figure 3 provides an example of PPA based on Houlihan and Lokey (2018). Panel A of Table 1 shows our sample construction. We start with 4,717 completed acquisitions during 2009 through 2018 in the Houlihan and Lokey PPA database. Out of these, 430 acquisitions (nine percent) have positive IPRD. We identify 31 additional acquisitions with IPRD through examination of company notes to the financial statements.[6] We match up the 461 acquisitions with total assets of the acquiring company. In Panels B through D of Table 1, we provide the details on these 461 acquisitions. Panel B shows that firms in our sample made 59 acquisitions in 2009 and 2010 but only 24 in 2017. In Panel C, we document that a substantial number of these acquisitions (198 or 42.9%) include a very small amount of IPRD in comparison to the total assets of the acquiring company (less than 0.5%). Panel D shows that the mean IPRD for the 461 acquisitions is $280.68 million (median is $16.00 million). These amounts are higher than the $87.42 million mean and $8.50 million median IPRD Dowdell and Lim (2015) report for 2009 through 2011 acquisitions. The mean IPRD to total assets for the acquiring company is 4.2% (median is 0.9%). The lowest IPRD recorded in an acquisition is 0.08 million ($76,000), which is 0.1% (untabulated) of the acquirer's total assets. The lowest IPRD to total assets of 0.0% is an IBM acquisition that includes $2.00 million in IPRD compared to IBM's total assets of $126.23 billion (the last two amounts are untabulated).

We attempt to determine how much of the acquired IPRD is impaired, completed, transferred to finished technology, or still incomplete. We believe that companies more likely provide this

[5] We thank Houlihan and Lokey (HL) for providing its proprietary PPA data. HL is an NYSE-listed global investment bank and it started to collect the PPA from Forms 10-K/Q, 8-K, or S-4 filings since the year 2003. HL PPA dataset classified identifiable intangibles into five categories. They are 1) completed technology, 2) IPRD, 3) trademarks and trade names, 4) customer-related assets, and 5) other identifiable intangibles such as unproven oil and gas rights, non-compete agreements, and leasehold interests.
[6] We examined IPRD activity for companies with significant IPRD acquisitions (greater than five percent of the acquirer's assets). We identified these additional IPRD acquisitions through this process.

information in the financial statements for “significant” or “material” IPRD acquisitions. We determine significant IPRD by dividing acquired IPRD in a year by total assets for the acquiring company. We consider a ratio of IPRD to total assets of greater than five percent as significant.

In Table 2 Panel A we document 99 acquisitions in which the acquired IPRD exceeds five percent of total assets of the acquiring company. We examine the notes to the financial statements for these companies in the acquisition year and subsequent years to determine what happens to the IPRD. By reading the notes, we determine that seven of the acquisitions involve asset acquisitions in which companies expense IPRD and three other acquisitions do not include IPRD. Out of the remaining 89 acquisitions with significant IPRD, we could determine what happened to the IPRD for 74 (83.1%). We discuss the 15 acquisitions where we cannot determine the future IPRD outcome in a subsequent section.

RESULTS

We trace the eventual success or failure of capitalized IPRD for 74 acquisitions by 56 companies (see Table 2 Panel B). These 56 companies made between one and four acquisitions with significant acquired IPRD.[7] Panel C shows 11 acquisitions with acquired IPRD in 2013 but only three in 2010. Panel D documents that the mean IPRD for the 74 acquisitions is $634.47 million (median is $81.54 million). The mean IPRD to total assets for the acquiring company is 18.0% (median is 12.8%).

We read the notes to the financial statements in the acquisition year and thereafter to investigate what happens to the capitalized IPRD after the acquisition. Table 3 presents information for the number of IPRD activity years available. An *IPRD activity year* for an acquisition refers to the number of firm years with IPRD information disclosed in Form 10-K, a designation that allows us to trace the outcome of capitalized IRPD under SFAS 141 (R). We consider IPRD “fully transferred out” if the company transferred at least 95.0% of the IPRD out of the account. For example, if a company acquired IPRD in 2009 and transferred all of it to completed technology in 2011, three *IPRD activity years* exist (2009, 2010, and 2011). The number of *IPRD activity years* for an acquisition depends on (1) how long it takes for the

[7] Our unit of analysis is an acquisition, not a firm year. There are 69 firm years in our sample with one significant IPRD acquisition. Additionally, there is one firm year with two and one firm year with three.

company to complete the IPRD or write it off as impaired, (2) when the acquisition occurred relative to the end of our sample period (2018), and (3) whether and when another firm subsequently took over the acquiring company.

Sample companies acquired 14 IPRD firms with only the acquisition year activity available (first row in Table 3 with the number of IPRD activity years = 1). Two companies transferred the IPRD out of the account in the acquisition year. For the 12 other acquisitions in row one, nine of the acquisitions are in 2018, the last year in our sample period, and three other acquisitions were made by acquirers that other firms subsequently acquired (i.e., targets of M&As). Rows (10) and (11) of Table 3 show the other extreme cases of three 2009 acquisitions with IPRD activity available for all 10 years. One company that made a 2009 IPRD acquisition in row (10) finally transferred out the IPRD in 2018, and two companies that made 2009 IPRD acquisitions in row (11) still report incomplete IPRD at the end of our sample period (2018). The *last IPRD activity year* for an acquisition refers to the most recent *IPRD activity year* and ranges from 2009 through 2018 and from the year of acquisition to nine years after the acquisition. Row (13) of Table 3 shows that the total number of IPRD activity years is 124 (125) for acquisitions acquiring firms transferred out (did not transfer out) the capitalized IPRD by the last IPRD activity year.

Table 4 presents descriptive statistics on the percentages of IPRD completed, impaired, and incomplete for all 74 acquisitions in our sample. Table 11 reports the findings of a separate analysis on the remaining 15 out of 89 total acquisitions in Table 2 whose IPRD outcome we could not determine from the footnote disclosure of acquiring firms. We calculate the descriptive statistics using cumulative IPRD completed and impaired for the *IPRD activity years* up to and including the *last IPRD activity year* (we define these in Table 3), and incomplete IPRD at the end of the *last IPRD activity year.* We divide each of these by IPRD acquired in the acquisition. For example, we might assume that a company acquired \$100 of IPRD in 2017 and completed \$25 in 2017 and wrote off \$15 in 2018 (last year of sample period). In such a case, the percent complete is 25.0% [\$25 / \$100], the percent impaired is 15.0% [\$15 / \$100], and the percent incomplete is 60.0% [\$(100-25-15) / \$100]. Mean IPRD impaired of 28.5% slightly exceeds the mean IPRD completed of 24.2%. The median IPRD completed and impaired of 0.0% indicates that for more than half of the IPRD acquisition years companies did not complete any IPRD and did not write off any as impaired.[8] In 13 acquisitions, companies transferred at least 95.0% of IPRD to completed technology, and in 13 other acquisitions, companies wrote off at least 95.0% of IPRD as impaired.[9]

Table 5 reports information on the first subsample: 36 acquisitions with at least 95.0% of the acquired IPRD moved out of the account. For each acquisition, we trace the cumulative IPRD percentage transferred to completed technology, written off, or sold. We then add these cumulative percentages of IPRD across all acquisitions. Row 0 of Table 5 shows that in two acquisitions, companies completed or wrote off nearly all of their IPRD in the year of acquisition. An acquiring firm transferred 97.0% of its acquired IPRD to completed technology, and in another acquisition an acquirer wrote off 100.0% of its IPRD, both in the year of acquisition. Row 1 of Table 5 shows the 11 acquisitions in which companies moved IPRD out of the account in the first year after the IPRD acquisition. In six acquisitions, the acquiring firm transferred all of its IPRD to completed technology (6.07) and in four acquisitions, the acquirers wrote off nearly all of their IPRD by the end of the first year after the acquisition year (3.91). One company sold its acquired IPRD in the first year after the acquisition year (1.00).

On average, for these 36 acquisitions, it took 2.44 years to clear the IPRD account. The acquiring companies transferred their capitalized IPRD to completed technology for a similar number of acquisitions (16.99 total or 47.3 %) as they wrote off IPRD to impairment (16.65 total or 46.4 %). The last three rows of Table 5 present these descriptive statistics. The success rate we find with our sample (47.3 %) exceeds the 13.8% approval rate Wong et al. (2019) report for drug development programs. If the drug development programs in Wong et al. (2019) include both in-house and acquired programs, then our results provide evidence that the success rate of IPRD exceeds the success rate of R&D. For most of the acquisitions (30 acquisitions, from adding row 0 through row 3, out of 36 total acquisitions or 83.3%), we also

[8] A firm could also sell the IPRD. We noted three sample acquisitions where a firm sold at least part of the IPRD.

[9] Later in Table 5 we investigate 36 acquisitions with IPRD transferred out. Besides the 26 acquisitions in Table 4, Table 5 includes ten additional acquisitions where parts of the IPRD acquired were transferred to completed technology, written off as impaired, or sold. Note that 27 acquisitions in the right most column of Table 4 are included in Table 7 which analyzes 38 incomplete IPRD acquisitions.

find the acquiring firm transferred the IPRD out of the account by the end of the third year after the acquisition.

In Table 6 we present the findings of our investigation into whether the value of IPRD acquired (unscaled) has a positive association with the percentage of IPRD transferred to completed technology and a negative association with the percentage of IPRD written off as impairment for this subsample of 36 acquisitions. We expect that IPRD projects more likely to succeed will have a higher value in the acquisition. Using one-tail tests, we find that IPRD has a weak positive association with the percentage transferred to completed technology (Pearson correlation = 0.22; one-tailed p-value = 0.10) but not a negative association with the percentage written off to impairment (Pearson correlation = -0.18; one-tailed p-value = 0.15). Consequently, we find a mixed result as to whether firms properly value the IPRD.

We read the notes regarding transfers to completed technology and impairments, and provide summary (untabulated) information below. Companies provided 30 notes regarding transfer of IPRD to finished technology. Nine of the notes discuss regulatory approval, including the Food and Drug Administration (FDA). In 12 of the notes, companies provided the amortization life of the finished technology ranging from 4 to 15 years. Eight of the notes discussed the commercial launch, start of marketing of the product, or placing the product into service. Seven of the notes discussed the following levels of completion: completion of the last IPRD product, substantive completion, developmental completion, and completion of technological feasibility.

Companies provided 34 notes regarding IPRD impairment. Ten of the notes referred to results of Phase 2 and Phase 3 clinical studies. Six other notes referred to a(n) partial clinical hold by the FDA, “not approval” letter from the FDA, negative regulator opinion, completed pilot study, evaluation, and unsuccessful validation. Companies reported 12 notes that discuss discontinuing, abandoning, cancelling, or delaying development or testing of IPRD projects. In five notes, companies attribute the impairments to reductions in revenue/cash flow estimates. In five notes, companies discussed strategy: current plans, change in strategy, reassessed the market size, consider other options, and focus on certain core products and no longer promote certain other products. In five notes companies attributed impairment to outside forces: termination of joint venture partnerships, strong competition, price reductions, creation of new drugs, or unavailability of additional capital. One company reported an impairment assessment before placing the technology into service, and another company calculated the IPRD fair value upon the decision to sell the IPRD. Finally, one company provided the IPRD impairment in a table without explanation.

Next, Table 7 presents test results on the remaining 38 IPRD acquisitions, where companies have not reclassified at least five percent of the IPRD. We use cumulative IPRD transferred to completed technology, written off, sold, and incomplete in the *last IPRD activity year* (defined in Table 3). Similar to Table 5, we add these amounts across acquisitions for each row. For these acquisitions the *last IPRD activity year* ranged from the acquisition year (12 acquisitions) in row 0 of Table 7 to the ninth year after the acquisition (2 acquisitions) in row 9 of Table 7. Nine of the 12 acquisitions with the acquisition year as its last year occurred in 2018, the last year of our sample period, and the other three acquisitions occurred in the year before another bidding firm acquired the original acquiring firm. Two companies in row 9 of Table 7 acquired IPRD in 2009. For one of them, 42.0% of the IPRD remained incomplete at 12/31/2018 and for the other 100.0%. Another company in row 8 of Table 7 acquired IPRD in 2010 and substantially all of it remained incomplete at 12/31/2018.

Overall, in Table 7 we find that 86.0% of the IPRD is incomplete by the end of the last year available. For these acquisitions, on average, companies wrote off a higher percentage of the IPRD (11.6%) compared to the percentage they completed (2.4%).

Next, we perform a cohort analysis based on different time periods to transfer the IPRD out of the account. We examine the results using three-year, five-year, and seven-year periods. Our three-year period group includes acquisitions with at least three years of information (acquisition year plus two subsequent years) or the IPRD was at least 95.0% transferred out by the end of the third year. We define the five-year and seven-year groups similarly.

Table 8 presents descriptive statistics on completed, impaired, and incomplete IPRD based on three-, five-, and seven-year periods for acquisitions in the sample. Similar to Table 4, we base the descriptive statistics on the last cumulative IPRD completed and impaired, and incomplete

IPRD divided by IPRD acquired up to the third, fifth, or seventh year. In Panel A, mean impaired IPRD of 25.9% slightly exceeds the mean completed IPRD of 22.5% using the three-year period sample.[10] But for both the five-year and seven-year period samples in Panels B and C mean completed IPRD exceeds mean impaired IPRD. In all three panels, mean completed and impaired IPRD are similar. Using the three-year period sample in Panel A, companies transfer out nearly half of the IPRD, on average (mean incomplete = 48.9%), with 40.7% of the IPRD transferred out for the median acquisition.

In Table 9, we investigate again, similar to Table 6, whether acquired IPRD (unscaled) is positively associated with the percentage of IPRD transferred to completed technology and negatively associated with the percentage of IPRD written off as impaired and incomplete, but here we do it with the three different sample periods. We find a positive association between acquired and completed IPRD for the five-year and seven-year samples (Pearson correlation = 0.30 and 0.24; p-value = 0.02 and 0.07, respectively), but we do not find a positive association between acquired and completed IPRD for the three-year sample (Pearson correlation = 0.04; p-value = 0.39). We also find a negative association between IPRD value acquired and the percentage of incomplete IPRD for the five-year sample (Pearson correlation = -0.25; p-value = 0.05), but we find an insignificant association for the three- and seven-year samples (Pearson correlation = 0.02 and -0.15; p-value = 0.45 and 0.18, respectively). Finally, we find an insignificant association between acquired IPRD and the percentage of impaired IPRD for all three sample periods.

We also investigate what happens to IPRD when another firm acquires a company with capitalized IPRD. Table 10 presents the nine companies in our sample that other firms subsequently bought out. For these nine companies, we compare the most recent IPRD balance to the IPRD amount the new acquiring firm recognized in the acquisition. For seven of the nine target companies, the new bidding firm paid more for IPRD than the target firm reports as the IPRD balance. The acquired IPRD could exceed the target IPRD balance if these seven targets had incomplete in-house R&D projects in addition to the capitalized IPRD

[10] The sample size for the three-year period is all 36 acquisitions in Table 6 plus all 38 acquisitions in Table 7 except for 18 acquisitions in the first two rows (12 acquisitions + 6 acquisitions) of Table 7 where the latest year available is 0 or 1.

projects or had made substantial additional progress on their capitalized IPRD but had not completed them. In contrast, for two of the nine targets (Cubist and Heartware), the bidding firm paid less than the capitalized IPRD balance the target firm reported in its balance sheet. In these cases, the target company could have completed the IPRD or written it off as impaired between the target balance sheet date and the acquisition date, and the company did not have valuable incomplete in-house R&D projects.

We investigated the subsequent acquisitions of Cubist and Heartware and found the following. In Merck's acquisition of Cubist, part of the target IPRD ($194.00 million) was approved by the FDA in December 2014 and included in product intangibles in the acquisition. Merck discontinued development of the remaining $43.40 million of target IPRD and assigned zero value to it in the acquisition. Merck recognized $50.00 million of IPRD in the acquisition related to a drug internally developed by Cubist. Medtronic recognized $602.00 million in technology-based intangible assets related to in-house R&D activities of Heartware International acquisition but zero related to the Heartware IPRD.

Our final analysis relates to the 15 out of 89 IPRD acquisitions for which we could not determine what happened to the IPRD from the footnotes of the acquiring firms. In some cases, a given company did not provide details on IPRD impairment or transfers to completed technology, and the impairments/transfers could apply to multiple possible IPRD acquisitions. For these companies, we could not match the impairment/transfers to specific IPRD acquisitions. We did not include these companies in our main sample but did examine their IPRD-related notes for overall success/failure information and details the companies provided on IPRD impairments/transfers to completed technology.[11]

Panel A of Table 11 presents overall IPRD activity for the seven companies for which we could not determine what happened to the significant IPRD acquisitions. For these companies we could determine the overall activity in the IPRD account from 2009 through 2018. For each company, we calculated total impaired, completed, sold, or otherwise changed IPRD over the

[11] There is one company (AbbVie) where we were not able to determine what happened to IPRD for one of their acquisitions, but we were able to determine it for two others. We kept the later two acquisitions in our test sample but did not include AbbVie in Table 11.

available years and then divided the result by the total acquired IPRD. We also calculated incomplete IPRD in the most recent year divided by total acquired IPRD. Panel A of Table 11 presents the means and medians for these percentages. For these seven companies, on average, nearly half of their IPRD was completed (47.2%), 31.0% impaired, and 16.8% incomplete. These companies successfully complete more of their IPRD projects as compared to our test sample (see Table 4). This finding likely resulted because three of the seven are large companies that made large and many acquisitions with substantial IPRD.[12]

Panel B of Table 11 reports whether companies provide different information on impairments versus transfers to completed technology. We examined all years for the seven companies, during which they recorded either an IPRD impairment or a transfer to completed technology, and we categorized each year as to whether the company specified the impairment or transfer to completed technology or did not. For the 39 company years with impairment, companies provided the details on the impairment for 26 of those years (66.7%). By contrast, companies provided details on the transfers to completed technology for only seven of the 26 company years (26.9%) with transfers to finished technology. Consequently, these companies are more likely to provide details on IPRD impairments as compared to IPRD transferred to completed technology. Probably, firms are reluctant to disclose the details of their IPRD success to avoid sharing their technological innovations with their industry competitors (Harris 1998).

CONCLUSIONS

Because of the accounting rule change for IPRD in SFAS 141 (R), companies could potentially record in their financial statements the success or failure of their IPRD projects. We investigate what happened to capitalized IPRD for a sample of companies with significant IPRD acquisitions and evaluate the success or failure rates of these projects. We determine what happened to IPRD for 74 out of 89 significant IPRD acquisitions. For our overall sample, acquisitions with IPRD transferred out, and three sub-samples with a minimum number of years of information, we find that the percentage of IPRD written off closely resembles the

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[12] The seven companies include Pfizer, Watson Pharmaceuticals, Bristol Myers Squibb, and Endo Pharmaceuticals which are the first, 17^{th}, 22^{nd}, and 37^{th} largest companies respectively in the 286 companies making IPRD acquisitions 2009 through 2018 based on total assets in their most recent year (untabulated).

percentage transferred to completed technology. We do not find that acquirers quickly write off their IPRD to try to match the expensing of IPRD prior to the rule change. Further, we find mixed evidence that firms properly value the IPRD in that the unscaled value of acquired IPRD acquired has a positive association with the percentage transferred to completed technology but does not have a negative association with the percentage written off.

We find that, with the changed accounting for IPRD, financial statement users can identify what happened to IPRD for most companies with significant IPRD acquisitions. For some companies that made a lot of IPRD acquisitions, we cannot determine what happened to IPRD in particular acquisitions. However, we do manage to estimate the overall success/failure rate for their IPRD projects. We also observe that companies tend not to provide details of their successful IPRD probably to keep their innovation success away from their rivals.

The limitations of our paper are as follows. A limited number of companies acquire firms with significant IPRD and are concentrated in the pharmaceutical industry. Our results for IPRD in these acquisitions may not generalize to all IPRD and R&D. Our study is descriptive. Future research may investigate insignificant IPRD acquisitions and IPRD in asset purchases which are still expensed.

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Figure 1
In-house R&D

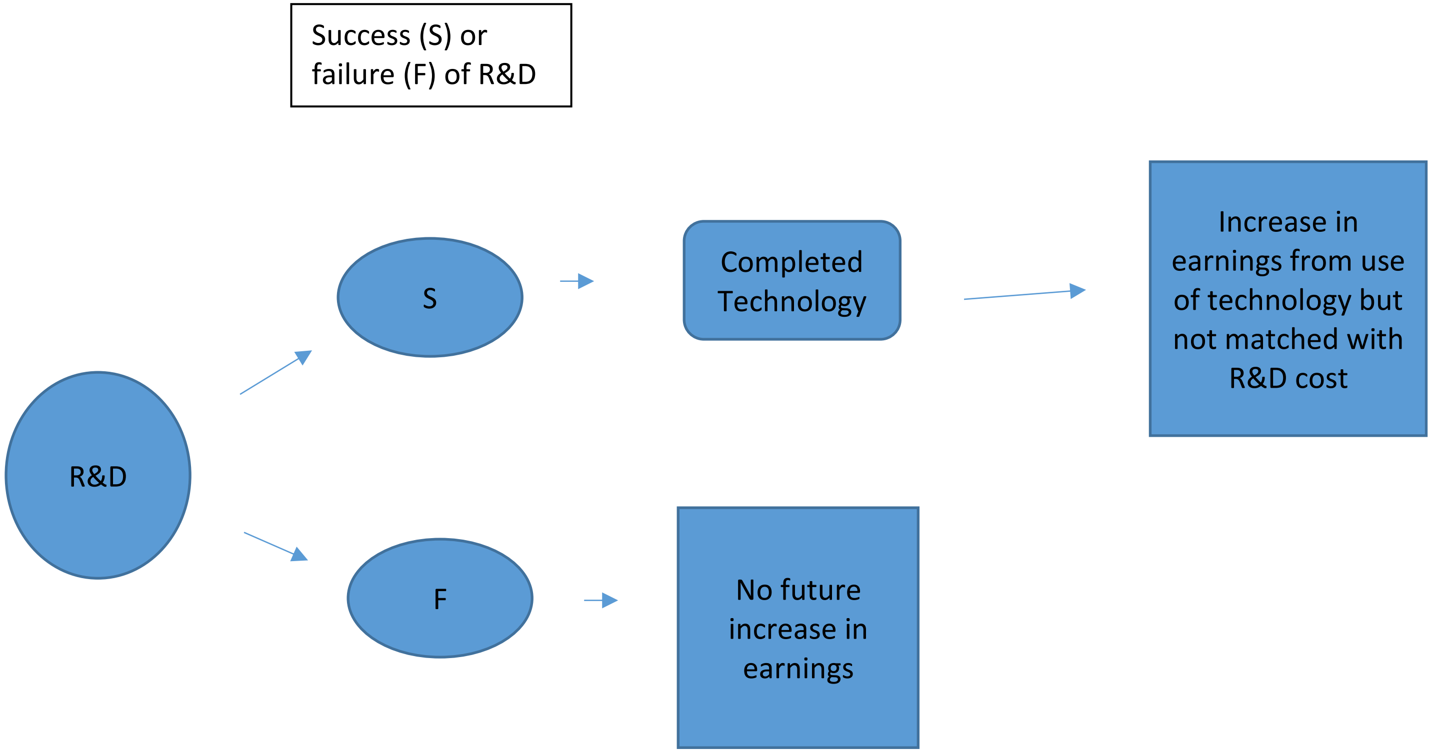

Figure 2
A Firm Acquires a Target Firm with IPRD

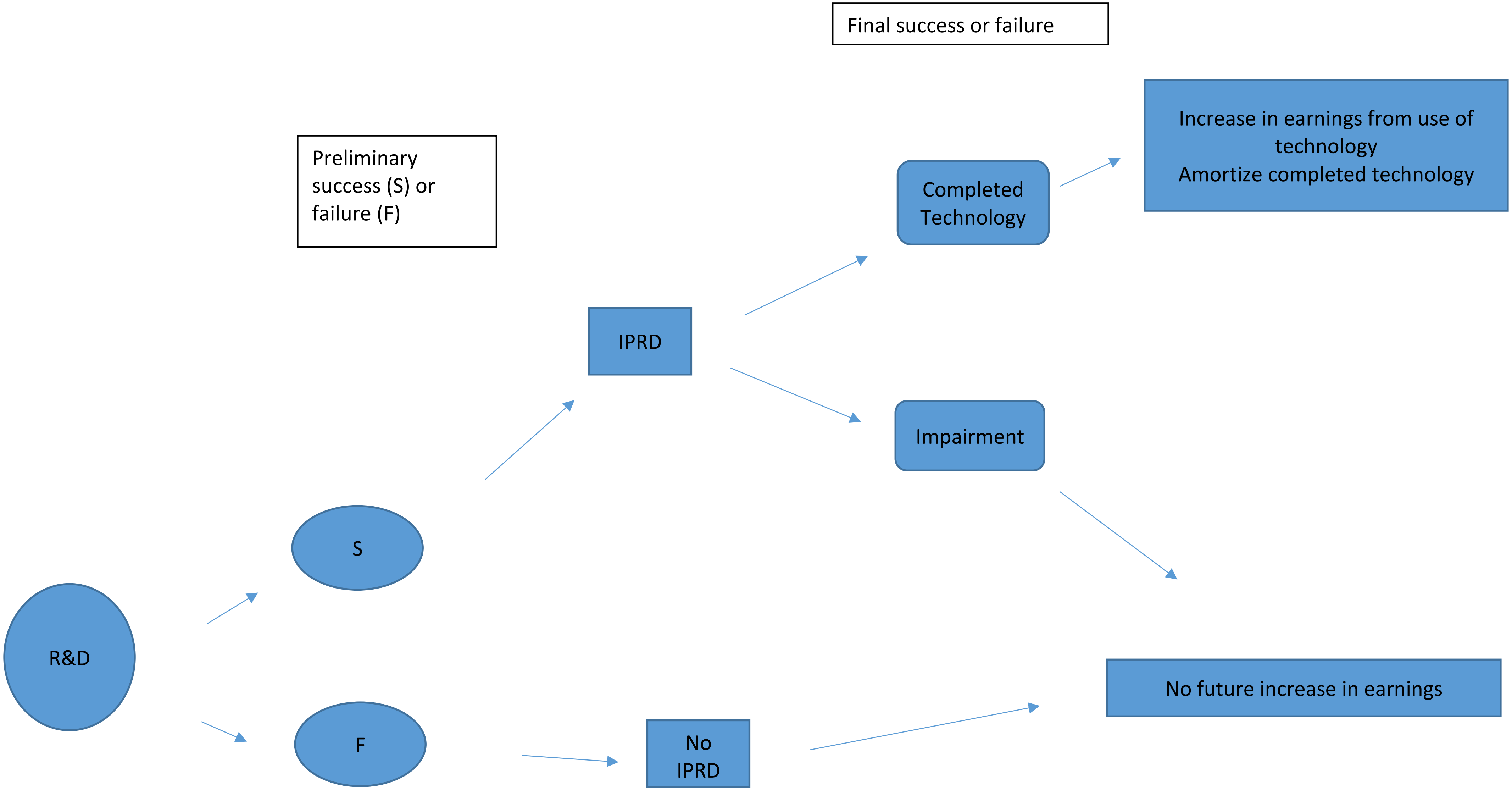

Figure 3
Purchase Price Allocation Structure

This figure is from the 2018 study by Houlihan and Lokey (HL), an NYSE-listed independent global investment bank. On the assets side: purchase consideration (PC) = Fair value of the target = current assets + tangible assets + identified intangible assets (IIA) + goodwill; most of the time, current assets and tangible assets are lumped together, so we only have tangible assets in the data. IIA = developed technology + in-process research and development + customer-related assets + trademarks and trade names + other identifiable intangible assets. On the liabilities side: PC = purchase price (PP) + non-interest bearing liabilities assumed.

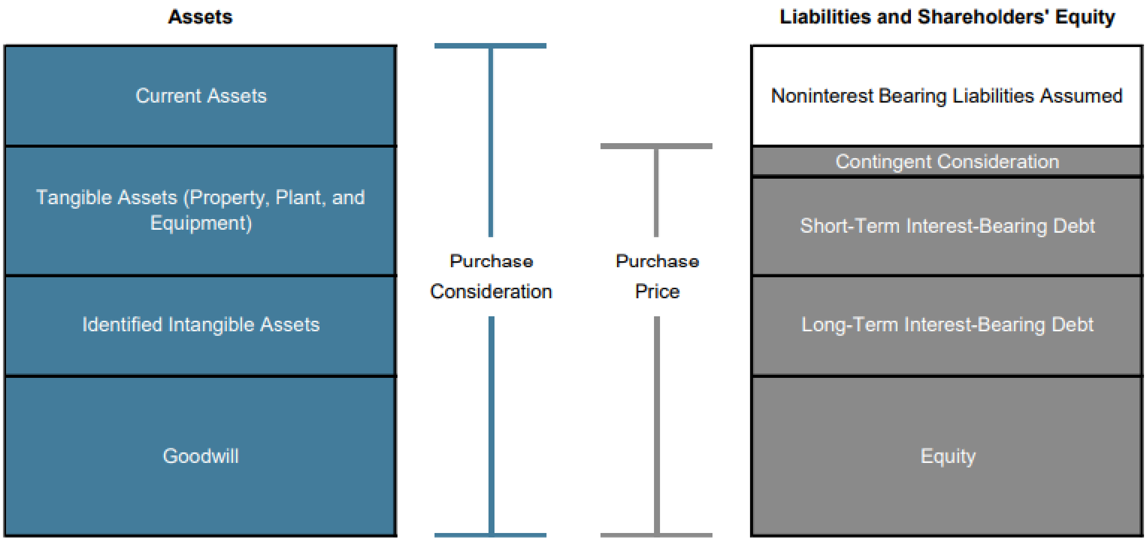

Table 1
Acquisitions with IPRD

Panel A: Sample reconciliation

Acquisitions in the Houlihan and Lokey database from 2009 through 2018		4,717
No IPRD acquired		(4,287)
Acquisitions with IPRD		430
Additional IPRD acquisitions identified		31
2009 – 2018 Acquisitions with IPRD matched up with total assets of the acquiring company		461

Panel B: Distribution by year

2009	59	
2010	59	
2011	56	
2012	42	
2013	37	
2014	48	
2015	40	
2016	44	
2017	24	
2018	52	
Total	461	

Panel C: Frequency by IPRD to total assets

Category	Count	%
IPRD/AT < 0.5%	198	42.9
0.05% < IPRD/AT < 1.0%	57	12.4
1.0% < IPRD/AT < 2.0%	55	11.9
2.0% < IPRD/AT < 3.0%	24	5.2
3.0% < IPRD/AT < 4.0%	16	3.5
4.0% < IPRD/AT < 5.0%	12	2.6
5.0% < IPRD/AT < 10.0%	45	9.8
10.0% < IPRD/AT < 20.0%	26	5.6
20.0% < IPRD/AT	28	6.1
Total	461	100.0

Panel D: Descriptive statistics in $ million

	IPRD	AT	IPRD/AT
N	461	461	461
Mean	280.68	16,842.16	4.2%
Median	16.00	1,906.90	0.9%
Maximum	14,918	212,949	64.6%
Minimum	0.08	9.73	0.0%

Table 2
Test Sample

Panel A: Sample reconciliation

2009 – 2018 Acquisitions with IPRD matched up with total assets of the acquiring company		461
IPRD less than 5% of total assets of acquiring company		(362)
Acquisitions IPRD greater than 5% of total assets of acquiring company		99
Asset acquisitions		(7)
Not IPRD		(3)
		89
Could not determine what happened to IPRD		(15)
Test sample		74

Panel B: Company years

Company years	Companies	Acquisitions	
1	44	44	
2	8	16	
3	2	6	
4	2	8	
Total	56	74	
Panel C: Distribution by year:			
2009			10
2010			3
2011			4
2012			4
2013			11
2014			10
2015			9
2016			9
2017			5
2018			9
Total			74
Panel D: Descriptive statistics in $ million	IPRD	AT	IPRD/AT
N	74	74	74
Mean	634.47	5,351.97	18.0%
Median	81.54	781.07	12.8%
Maximum	6,980.00	76,250.00	64.6%
Minimum	2.17	9.73	5.1%

Table 3
Number of IPRD Activity Years

Row number	Number of *IPRD Activity Years* for each acquisition	IPRD Transferred	Last IPRD activity year	Total number of IPRD activity years
(1)	1	2	12	14
(2)	2	11	6	34
(3)	3	7	6	39
(4)	4	10	4	56
(5)	5	2	4	30
(6)	6	2	3	30
(7)	7	1		7
(8)	8			
(9)	9		1	9
(10)	10	1		10
(11)	10 (still incomplete)		2	20
(12)	Total number of acquisitions	36	38	
(13)	Total number of IPRD activity years	124	125	249

An *IPRD activity year* for an acquisition refers to the number of firm years with IPRD information disclosed in Form 10-K, a designation that allows us to trace the outcome of capitalized IRPD under SFAS 141 (R). We consider IPRD "fully transferred out" if the company transferred at least 95.0% of the IPRD out of the account. For example, if a company acquired IPRD in 2009 and transferred all of it to completed technology in 2011, three *IPRD activity years* exist (2009, 2010, and 2011). The number of *IPRD activity years* for an acquisition depends on (1) how long it takes for the company to complete the IPRD or write it off as impaired, (2) when the acquisition occurred relative to the end of our sample period (2018), and (3) whether and when another firm subsequently took over the acquiring company.

Sample companies acquired 14 IPRD firms with only the acquisition year activity available (first row in Table 3 with the number of IPRD activity years = 1). Two companies transferred the IPRD out of the account in the acquisition year. For the 12 other acquisitions in row one, nine of the acquisitions are in 2018, the last year in our sample period, and three other acquisitions were made by acquirers that other firms subsequently acquired (i.e., targets of M&As). The *last IPRD activity year* for an acquisition refers to the most recent *IPRD activity year* and ranges from 2009 through 2018 and from the year of acquisition to nine years after the acquisition.

Table 4
Descriptive Statistics on the Percentages of IPRD Completed, Impaired, and Incomplete

	% Completed	% Impaired	% Incomplete
Number of acquisitions	74	74	74
Mean	24.2%	28.5%	44.0%
Median	0.0%	0.0%	16.7%
Maximum	100.0%	100.0%	100.0%
Minimum	0.0%	0.0%	0.0%
Number greater than 95%	13	13	27

Table 4 above presents descriptive statistics on percentages of IPRD completed, impaired, and incomplete. For example, we might assume that a company acquired $100 of IPRD in 2017 and completed $25 in 2017 and wrote off $15 in 2018 (last year of sample period). In such a case, the percent complete is 25.0% [$25 / $100], the percent impaired is 15.0% [$15 / $100], and the percent incomplete is 60.0% [$(100-25-15) / $100]. We apply this algorithm to all 74 acquisitions in our sample and compute the descriptive statistics above.

Table 5
IPRD Acquisitions Completed, Impaired, or Sold

# of years after IPRD Acq. (1)	Completed (2)	Impaired (3)	Sold (4)	Total (5)	Number of acqs. (6)	Weighted # of years (7)
0	0.97	1.00	0.00	1.97	2	0
1	6.07	3.91	1.00	10.98	11	11
2	2.53	4.47	0.00	7.00	7	14
3	5.27	3.44	1.28	9.99	10	30
4	1.00	1.00	0.00	2.00	2	8
5	1.15	0.83	0.00	1.98	2	10
6	0.00	1.00	0.00	1.00	1	6
7	0.00	0.00	0.00	0.00	0	0
8	0.00	0.00	0.00	0.00	0	0
9	0.00	1.00	0.00	1.00	1	9
Total	16.99	16.65	2.28	35.92	36	88
Average						2.44
%	47.3%	46.4%	6.3%	100.0%		

Table 5 above analyzes how long it takes for companies to move at least 95.0% of the IPRD out of the account for 36 acquisitions. For each acquisition, we trace the cumulative IPRD percentage transferred to completed technology, written off as impaired, or sold to other firms, and determine the first year when at least 95.0% was transferred out of the account. We then add these cumulative percentages of IPRD across all acquisitions. Row 0 of Table 5 shows that in two acquisitions, companies completed or wrote off nearly all of their IPRD in the year of acquisition. An acquiring firm transferred 97.0% of its acquired IPRD to completed technology, and in another acquisition an acquirer wrote off 100.0% of its IPRD, both in the year of acquisition. Weighted number of years in column (7) is the number of acquisitions in column (6) times number of years after the acquisition in column (1).

Table 6
Correlations

Pearson Correlations (p-values)	IPRD	Completed	Impaired
IPRD		0.22 (0.10#)	-0.18 (0.15#)
Completed			-0.89 (0.00)

The sample for this table is the 36 acquisitions with IPRD transferred out from Table 5.
Variable definitions:
IPRD – unscaled value of IPRD in the acquisition year
Completed - cumulative IPRD completed and transferred to finished technology in the *last IPRD activity year* (defined in Table 3) divided by IPRD.
Impaired - cumulative IPRD impaired in the *last IPRD activity year* (defined in Table 3) divided by IPRD.
Numbers in parentheses are p-values. # denotes one-tailed p-value and the remaining p-value is two-tailed.

Table 7
Incomplete IPRD

# of Years after IPRD Acq.	Completed	Impaired	Sold	Incomplete	Total	Number of Acqs.
0	0.00	0.00	0.00	12.00	12.00	12
1	0.20	0.01	0.00	5.79	6.00	6
2	0.00	2.37	0.00	3.63	6.00	6
3	0.51	0.93	0.00	2.56	4.00	4
4	0.00	0.83	0.00	3.10	3.93	4
5	0.00	0.00	0.00	3.00	3.00	3
6	0.00	0.00	0.00	0.00	0.00	0
7	0.00	0.00	0.00	0.00	0.00	0
8	0.00	0.00	0.00	0.94	0.94	1
9	0.18	0.25	0.00	1.42	1.85	2
Total	1.58	4.67	0.00	35.45	37.72	38
%	2.4%	11.6%	0.0%	86.0%	100%	

Table 7 is similar to Table 5 and it shows cumulative IPRD transferred to completed technology, written off as impaired, sold to other firms, and remain incomplete divided by acquired IPRD as of the *last IPRD activity year* (defined in Table 3) for 38 acquisitions where at least 5.0% of the IPRD is still in the account (incomplete). For each row we add across acquisitions. For example, for three acquisitions, acquirers report five years of information after the acquisition with all of the IPRD still incomplete five years after the acquisition.

Table 8
Descriptive Statistics on the Percentages of IPRD Completed, Impaired, and Incomplete Over Different Time Periods

Panel A: Three-year period

	% Completed	% Impaired	% Incomplete
N	56	56	56
Mean	22.5%	25.9%	48.9%
Median	0.0%	0.0%	40.7%
Maximum	100.0%	100.0%	100.0%
Minimum	0.0%	0.0%	0.0%

Panel B: Five-year period

	% Completed	% Impaired	% Incomplete
N	46	46	46
Mean	34.7%	32.9%	27.3%
Median	0.0%	5.9%	0.0%
Maximum	100.0%	100.0%	100.0%
Minimum	0.0%	0.0%	0.0%

Panel C: Seven-year period

	% Completed	% Impaired	% Incomplete
N	39	39	39
Mean	44.0%	40.8%	9.0%
Median	16.1%	16.0%	0.0%
Maximum	100.0%	100.0%	100.0%
Minimum	0.0%	0.0%	0.0%

Table 8 above presents descriptive statistics on cumulative IPRD completed, impaired, and incomplete IPRD divided by IPRD acquired in the last year available based on three-, five-, and seven-year period samples. The three-, five-, and seven-year period samples includes acquisitions with at least three, five, or seven years of information, or the IPRD was at least 95% transferred out by the end of the third, fifth, or seventh year.

Table 9
Correlations for Alternative Time Period Samples

Panel A: Three-year period

Pearson Correlations (p-values)	IPRD	Completed	Impaired	Incomplete
IPRD		0.04 (0.39#)	-0.03 (0.40#)	0.02 (0.45#)
Completed			-0.31 (0.02)	-0.56 (0.00)
Impaired				-0.55 (0.00)

Panel B: Five-year period

Pearson Correlations (p-values)	IPRD	Completed	Impaired	Incomplete
IPRD		0.30 (0.02#)	-0.04 (0.38#)	-0.25 (0.05#)
Completed			-0.49 (0.00)	-0.50 (0.00)
Impaired				-0.40 (0.01)

Panel C: Seven-year period

Pearson Correlations (p-values)	IPRD	Completed	Impaired	Incomplete
IPRD		0.24 (0.07#)	-0.12 (0.24#)	-0.15 (0.18#)
Completed			-0.73 (0.00)	-0.30 (0.06)
Impaired				-0.26 (0.10)

Numbers in parentheses are p-values. # denotes one-tailed p-value and the remaining p-values are two-tailed.

Table 10
Sample Acquiring Companies Subsequently Acquired

Target	Acquiring Company	Target IPRD (in millions)	B/S Date	Acquisition IPRD (in millions)	Acquisition Date
Acquisition IPRD > Target IPRD					
Adventrx (changed name to Mast Therapeutics)	Savara	$8.55	12/31/2016	$21.96	4/27/2017
Allergan	Actavis	1.179.10	12/31/2014	9,700.00	3/17/2015
Astex Pharmaceuticals	Otsuka Pharmaceutical	38.66	6/30/2013	270.92	10/11/2013
Galena Biopharma (previously RXI Pharm.)	Sellas Life Sciences	12.86	9/30/2017	17.60	12/29/2017
GigPeak	Integrated Device Technology	8.06	12/31/2016	10.20	4/4/2017
Medicis Pharmaceutical	Valeant Pharmaceuticals International	85.97	12/31/2011	153.82	9/1/2012
Onyx Pharmaceutical	Amgen	171.50	6/30/2013	1,160.00	8/1/2013
Acquisition IPRD < Target IPRD					
Cubist Pharmaceutical	Merck	237.40	9/30/2014	50.00	12/31/2014
Heartware International	Medtronic	10.80	6/30/2016	0.00	8/1/2016

Table 11
Seven Companies – Could Not Determine What Happened to IPRD

Panel A: Mean and median IPRD results

% of acquired IPRD	Mean	Median
Impaired	31.0%	23.1%
Completed	47.2%	47.3%
Sold	0.9%	0.0%
Other	-12.1%	-1.1%
Incomplete	16.8%	5.5%

Panel B: Years with IPRD impairment or transfer to finished technology

	Provides details?		
	Yes	No	Total
Impairment	26	13	39
	(66.7%)	(33.3%)	
Transfer to finished technology	7	19	26
	(26.9%)	(73.1%)	
Total	33	32	65
Chi-squared statistic (p-value)	9.86	(0.002)	

THE IMPACT OF DATA ANALYTICS AND ARTIFICIAL INTELLIGENCE ON THE FUTURE ACCOUNTING PROFESSION: PERSPECTIVES FROM ACCOUNTING STUDENTS

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THE IMPACT OF DATA ANALYTICS AND ARTIFICIAL INTELLIGENCE ON THE FUTURE ACCOUNTING PROFESSION: PERSPECTIVES FROM ACCOUNTING STUDENTS

ABSTRACT

This study shows students' perceptions about data analytics (DA) and artificial intelligence (AI) and what the technologies might bring about to the business world and accounting profession. Compared with prior research focusing on accounting educators' opinions, we believe that it is critical to examine students' perceptions because students will join in the future labor force and experience a transition to a data-driven world; hence, they should have a built-in interest in what to expect.

The survey results show that students believe accounting jobs will be replaced by DA and AI, and the replacements will most likely start in entry-level positions. Most respondents believe computers are more efficient than humans in detecting fraud, but they are also concerned about ethical issues in using technology. Foreseeing the data-oriented future, the students understand the importance of having the skills in DA and AI and prefer early exposure to those technologies while at school compared with at work. The limitations or concerns related to these new technologies are the lack of communication and social touch, the threat to human's job security, and the potential breach of data privacy.

In addition, we offer some suggestions on resolving the gap between the number of positions demanding DA and AI skills and the number of qualified candidates. Because students are afraid to be replaced by technologies in the future and want to adapt to the data-oriented job market, companies can look for ways to build infrastructure to help smooth the transition from academic programs to work, such as sponsoring accounting degree or certificate programs to help students build in-demand skills, establishing venues for regular dialogues with accounting educators, and strengthening connections with students by visiting classes and participating in mentoring programs.

INTRODUCTION

Data analytics (DA) is the process of gathering, sorting, and analyzing data to develop business solutions through technology tools (Bishop-Monre and Phillips 2021). In recent years, the role of accountants has expanded from applying accounting principles to analyzing accounting issues (Moore and Felo, 2022). An increasing number of accountants have had experience in developing and utilizing DA in their jobs (Tscheakart et al., 2016). A business survey by McKinsey Global Institute (2012) shows that, out of a total of 1,468 respondents, 67% of corporate leaders consider “Big Data and analytics” a priority in their business strategies. This trend has continued to grow for public and private accounting positions. According to the PwC’s annual global survey (PwC, 2015a)[1], most CEOs agree that DA will continue to be highly desirable in their business practices in the future.

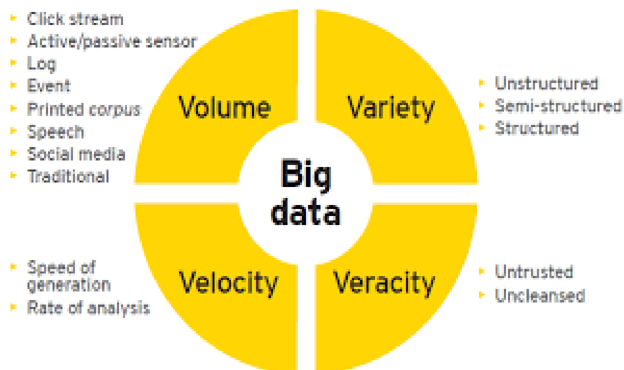
Accounting information processed by DA are commonly regarded as business datasets that are too large and complex for existing systems with traditional capabilities to capture, store, manage, and analyze to reveal patterns, trends, and associations (Richardson, Teeter, and Terrel, 2019). Similarly, the studies by Brown-Liburd, Issa, and Lombardi (2015) and Huerta and Jensen (2017) refer to Big Data in accounting as gathering volumes of structure and unstructured data from various financial and nonfinancial sources. According to the IBM data scientist infographic[2] (see Figure 1), DA encompasses 4Vs: volume, variety, velocity, and veracity. DA lies within the broad spectrum of processes in which many insights are extracted from operational, financial, and other forms of electronic data by the organization (KPMG, 2012). The use of DA has key implications for accounting measurement and representation methods, formalization of accounting procedures, semantic understanding of accounting-related phenomena, assurance procedures, and other issues related to social welfare and accounting education (Moffit and Vasarhelyi, 2015; Murthy and Geert, 2017).

With the demand for more powerful processing capabilities, many professionals have recognized that one of the most in-demand emerging technologies is artificial intelligence (AI). Regarding AI, 72% of business leaders believe that AI will be an advantage of future businesses (PwC, 2017a). The scope of AI ranges from machine learning (ML), which uses software to analyze data and tackle tasks much faster than human beings could do, to robotic process automation (RPA) [3],

[1] 85% of the surveyed CEOs state they put a high value on data analytics for the company based on results of 18th annual global survey by PwC (2015a).
[2] Refer to https://www.ibmbigdatahub.com/
[3] Refer to Cooper, Holderness, Sorensen, and Wood (2019) for the benefits, opportunities, and challenges for implementing RAP in public accounting. In addition, Mezzio, Stein, and Stein (2019) describe technological transformation of tax practices’ internal processes, and interactions with regulatory agencies as a fourth industrial revolution. They suggest that RPA can streamline a structured process, automatically extract tax data for review

which advances operations and streamlines mundane tasks. The development of AI is expected to tremendously benefit the business world. The McKinsey Global Institute report (2017a) emphasizes that recent developments in AI, ML, and RPA have put us on the cusp of a new digital age, and the predictive models suggest that half of today's work activities could be automated by 2055, but this could happen up to 20 years earlier or later, depending on various factors and economic conditions (McKinsey, 2017a).

Figure 1. 4 Vs of Data Analytics



(Retrieved from EY's Big Data report (EY, 2014))

Recognizing that, in the era of DA and AI, efficiency and productivity in accounting routines, such as processing immense amounts of data, can be achieved by using advanced intelligent technologies, we use terms of the Big Data, DA, and AI interchangeably to encompass all data tools and analytical processes that are available and transformative in achieving productivity and efficiency in accounting.

Accounting education evolves at a fast pace and often falls behind the development of business practices. Several accounting studies have provided evidence of the gap between what accounting programs usually offer and what the industry demands (Bolt-Lee and Foster, 2003; Jackling and De Lange, 2009; Richardson and Watson, 2021; Yu, Churyk, and Chang, 2013). The

and analysis, and create efficiencies for the tax compliance functions by creating a 70% time saving using the automation process.

impact of this gap is not limited to “the entry-level accountants…but also many ill-equipped seasoned accountants” (Richardson and Watson, 2021, p. 131). A high percentage of responses in a recent Sage survey indicate, echoed by accounting scholars, that the accounting profession needs to adopt the latest technology quickly to maintain its competitiveness (Richardson and Watson, 2021; Thomas-Bryant 2019). Despite the efforts of some accounting educators to embrace DA and AI in their teaching, we need to realize that changes in curriculum take time. A recent survey indicates that accounting departments are not strongly positioned to address the changes to the CPA licensure model, with ever-growing importance placed on data analytical skills (Losi et al., 2022). Some studies, such as Andiola, Master, and Norman (2020), Sledgianowski, Gomaa, and Tan (2017), and Watty, McKay, and Ngo (2016), find that accounting professors and departmental chairpersons are still debating how—and to what extent—academia should incorporate the DA and AI concepts into the accounting curriculum. No implementable solutions have been achieved yet.

In the current study, we examine the perceptions of accounting students when it comes to understanding whether they are ready to transition to a business environment full of opportunities and challenges brought about by DA and AI in the future. As Hart (2017) notes, students nowadays have been exposed to many advanced technologies from very young ages.

We developed a survey with relevant questions and administered it in 2019 to a group of randomly selected accounting undergraduate students on the campus of a midsized public university in the United States. The survey results indicate that the respondents sense the threat from DA and AI. Most believe that accounting jobs will be replaced by DA and AI in the near future, although entry-level positions are seen as the most vulnerable and likely to be replaced. Most realize the advantages of DA and AI in analyzing businesses and detecting fraud but are very concerned about ethical issues, including data privacy and data ownership. For example, Martin (2015) analyzes Big Data as an industry and identifies ethical issues that arise from reselling consumers’ data to the second market for Big Data. Most respondents agree that governmental regulations are necessary to limit the DA and AI functions to ensure data privacy and human job security. Most students feel the need to adapt to the data-driven business environment in the future and would like to learn DA and AI skills while at school rather than on the job. Students see the need for human beings in the labor force because they realize that humans are good at communicating and socializing. In general, the respondents are open to using DA and AI as tools to assist tasks but are relatively concerned about being replaced by the technologies.

Our study differs from prior studies by contributing to the literature in the areas of the accounting education and profession in the following ways. Although there is literature on the impact of accounting DA (Andiola, Master, and Norman, 2020; Dzuranin, Jones, and Olvera, 2018; Huerta and Jensen 2017; Watty, McKay, and Ngo, 2016), most studies investigate the industry practitioners' or accounting faculty's perspectives rather than that of students. We believe that it is critical to examine students' perceptions because they will be—and some of them already are—the very participants in the era of DA and AI[4]. Job opportunities in the areas of DA and AI look quite promising in the future. As projected by the McKinsey Global Institute report (2011, 2017a, 2017b), a large gap will exist between the number of positions that demand DA skills and number of qualified people in the labor force. In the United States alone, by 2030, about 140,000 to 190,000 such job positions will be hard to fill because of the lack of qualified candidates. The present study also gleans opinions from students about DA- and AI-related issues that have kindled heated discussions among business leaders and accounting professionals, such as job security, data privacy, and social and ethical complexities. The results will help accounting educators understand students' perspectives about DA and AI and inform their curriculum planning and design. Finally, the study offers some insights into addressing the problem of inadequate qualified candidates. Because students are afraid of being replaced by technologies in the future and do have the desire to adapt to the data-oriented business environment, companies can look for ways to build infrastructure to help smooth the transition from school to

[4] Please note that the current study does not intend to engage in any debates such as if accounting DA should be required and incorporated into the accounting curriculum or how to teach DA to business students. There is research that specifically covers these topics.

work, such as sponsoring accounting degree or certificate programs to help students build in-demand skills, establishing venues for regular dialogues with accounting educators, and strengthening connections with students by visiting classes and participating in mentoring programs.

The rest of the paper is organized as follows: The next section explains what DA and AI are, discusses their impacts on the accounting profession, and develops key topics covered by this research. The third section introduces the research method and describes the survey results. The last section concludes the paper and offers suggestions.

PRIOR LITERATURE AND RESEARCH DEVELOPMENT

This section first describes the application of DA and AI technologies in accounting, which centers on two major professional areas: audit and tax. Then, some ethical and societal concerns raised in the application of DA and AI will be discussed, followed by key research topics.

Accounting data analytics and artificial intelligence

Accounting DA usually consists of large volumes of transaction data and, often times, a collection of complex datasets. Gartner (2011) depicts Big Data as the data volume that exceeds the reach of commonly used hardware environments and software tools, which capture, manage, and process data within a tolerable elapsed time for its users. Franks (2012) and the McKinsey Global Institute (2011) also hold very similar descriptions of Big Data. Many accounting practitioners understand the trend and recognize that accounting DA encompasses analyses critical to the success of their career (Huerta and Jensen, 2017). Therefore, overall speaking, DA can also help businesses uncover valuable insights within their financials, identify potentials for process improvement, and manage operational risk and even capital budgeting (Angelo, Ayers, and Stanfield, 2018).

It is hard for spreadsheets and other widely used accounting software programs to meet the ever-growing data volume and need for optimization. Therefore, many DA tools are built on AI, ML, and RPA. These cutting-edge technologies have withstood the challenge of the explosion of data in business transactions by applying a variety of tools to clean, visualize, construct, fully use data, and eventually draw conclusions or inferences to benefit business decision-making (Du, 2016). Augmented with RPA's ability to handle routine tasks and AI's cognitive capabilities, most jobs can streamline workflows, increase efficiency, and supercharge productivity. Thus, it is estimated that the combined adoption of RPA, ML, and AI can give a bounce to the global economy by an annual growth of 0.8–1.4% from 2015 to 2065, whereas the AI market is forecast to reach a monumental $390.9 billion by 2025 (McKinsey 2017b). However, McKinsey's report (2017a) still finds that realizing automation's full potential requires people and technology to work hand in hand.

In the current study, the terms of accounting Big Data, DA, and AI are used interchangeably because the topics are closely related and sometimes intertwined. Our research aims to use them in combination as a notion for all data tools and analytical processes applied to increase productivity and efficiency in accounting tasks.

Impacts of DA and AI on the landscape of the accounting profession

There have been many recent calls for accounting DA to be performed in specialized areas, such as audit and other assurance services (Alles, 2015; Cao, Chychyla, and Stewart, 2015; Chan and Kogan, 2016; Moffit and Vasarhelyi, 2015), forensic accounting (Ernest and Young, 2018; Novack, 2013; Rezaee and Wang, 2019), management accounting (Applebaum, Kogan, Vasarhelyi, and Yan 2017), tax practices and IRS operations[5] (Franklin, Morrow, and Novak, 2020; Guerriero, Engebretson, and Parker, 2019), accounting information systems (Murthy and Geert, 2017; Coyne, Coyne, and Walker, 2016; Coyne, Coyne, Walker, 2018), and capital budgeting (Angelo, Ayers, and Stanfield, 2018).

[5] Please see the IRS strategic goals on the advance data and analytics: https://www.irs.gov/about-irs/strategic-goals/advance-data-analytics

Auditing and taxation are two key services from which many accounting firms generate major revenues, thus having incentives to make significant amounts of investment in DA solutions. A fair number of discussions have been made by academia and industry about the application of DA and AI in these two areas. Deloitte (2016) claims that tax analytics opens a new era for tax planning and compliance. In particular, as pointed out by the report, tax analytics is a useful tool for recurring tasks on a daily basis, such as understanding drivers of tax in key areas, predicting earnings and tax impacts, making comparisons between units over time, and analyzing the implications of sales of assets and other major events (Deloitte, 2016; Franklin, Morrow, and Novak, 2020). EY (2020) also refers to the benefits that data-gathering platforms can bring about by enabling the matching and sharing of taxpayers' data. For example, tax authorities can use analytics to mine data to help increase tax collections, target compliance initiatives, and improve overall efficiency. As for auditing and other assurance services, accounting DA tools are capable of improving the risk assessment process, the substantive procedures, and tests of controls. Audit DA can help automate and enhance traditional manual procedures and offer new ways of visualizing and analyzing results. Alles (2015) commeasures future audit development with clients using accounting Big Data, asserting that audit risk judgment will rely more on real-time DA. Some audit analytics proponents, such as Tang and Karim (2017), support the fundamental change of the audit practice to population audit from sampling audit to identified risk areas because a wider range and time period can bring better insights. A similar notion is also prescribed to analyze all entries within the general ledger for anomaly detection by PwC (2018). Alles and Gray (2016) propose several advantages of applying DA in audit: (a) strong predictive power for setting expectations of financial auditors and predictive models for going concerns; (b) rich data source to identify potential fraudulent activities; and (c) analyze all data to increase probability of discovering red flags, smoking guns, and suspicious outliers. Another major accounting firm, Binder Dijker Otte (BDO), also offers a detailed description of its use of audit DA[6]:

[6] Refer to BDO's website on its use of data analytics and how it enhances audit quality: https://www.bdo.com/insights/assurance/corporate-governance/data-analytics-enhancing-audit-quality

… [audit DA] include establishing expectations, applying a degree of precision that would identify a material misstatement of the financial statements, performing an analysis based on reliable data, and investigating and obtaining corroborated explanations for all variations from expectations above a specified investigation threshold…Consideration of the internal controls environment and any system deficiencies, including program change controls and access management controls, is also a critical component of data analytics. (BDO, 2020)

Deloitte (2020) has developed a summary table (see Figure 2) to compare traditional audit procedures and audit steps with those embedded with DA. Deloitte (2020) suggests analytics as a “bolt-on” to the audit (i.e., during fieldwork alone) that drives incremental rather than transformational benefits. By utilizing bots, robots, and drones in many audit processes, such as inspecting, monitoring, and evaluating, auditors can perform their work faster and at lower costs (Applebaum and Nehmer, 2017). As a result, the audit shifts from a checklist or sample approach to a sustainable insight-driven decision-making process. As Deloitte (2020) puts it, audit analytics is about delivering business insight and enhancing the way an audit works. Munoko, Brown-Liburd, and Vsarhelyi (2020) offer their practical insights based on a survey of CPA firms on the impacts of DA and AI on the auditing profession; however, in their study, there are ethical, legal, and economic concerns regarding AI application that also deserve to be addressed.

Some practitioners believe that human beings play an irreplaceable role in the analytical process. McKinsey’s report (2017a) acknowledges that, to realize the full potential of AI technology, people and technology need to work together. For instance, auditors need to communicate to data specialists the subjects of programming so that the latter can understand what the analytics of a given transaction need to be accomplished. Auditors also need to determine how the analytics of a given dataset can improve the audit task and potentially lead to useful decision insights for the client (Tysiac, 2020).

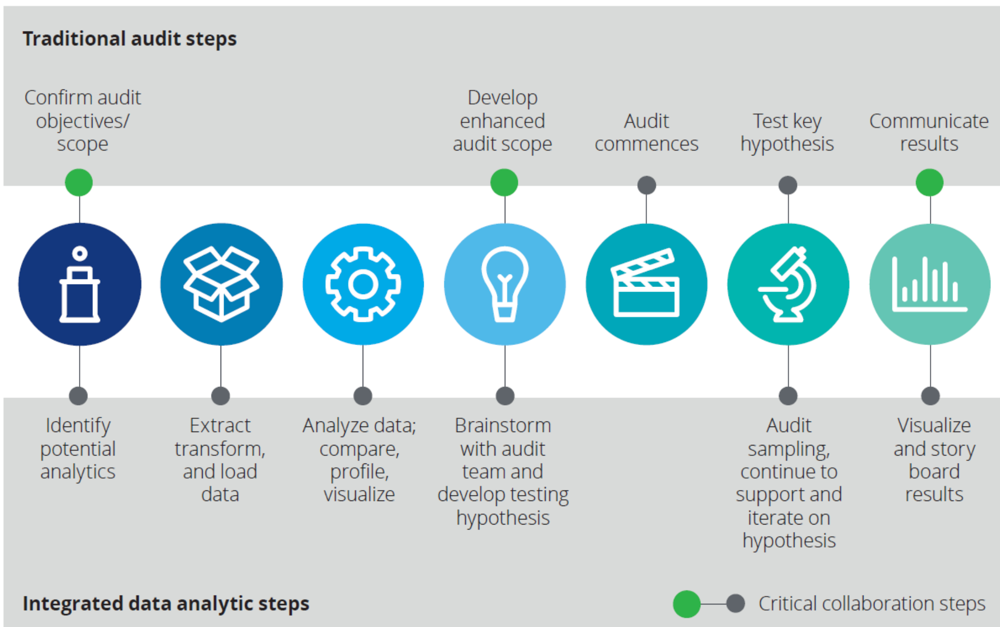
The accounting profession values analytical skills and is eager to recruit talent with the capability. For instance, Big-4 firms have publicly announced efforts in the domain of DA, particularly for assurance services (Applebaum, Kogan, and Vasarhelyi, 2017, page 2). As mentioned, the accounting profession also forecasts a great shortage of college graduates who will be well prepared for positions that require data analytical expertise (Jackling and De Lange, 2009; Yu, Churyk, and Chang 2013; McKinsey, 2017b). In recent years, PwC (2015b) has been encouraging accounting graduates to develop a data-driven mindset and master the advanced analytics skillset. Similar examples in other accounting firms are numerous. EY has recognized that developing a pipeline of employees with DA and AI skillsets will be the key to better serving clients in the future and launched the Next-Wave strategy in 2019 to leverage its global integration and teaming focus across the business with the goal of transforming itself using data, technologies, and its diverse talent pool. In partnership with reputable universities and accounting programs, KPMG is building a specialized accounting graduate program focusing on DA[7]. It is fair to say that both top accounting programs and big accounting firms have explicitly pointed out the critical skillset that accounting graduates should command to improve their career prospects. Therefore, it is important to study how students perceive the impact of DA and AI on their future job opportunities.

However, embracing DA and AI technologies in the business world is not without concern. In light of the large volume and complex collection processes, some opponents have raised important ethical concerns that could set back the use of Big Data, one of which is data privacy. In a survey of CEOs on trends shaping businesses, 91% of the participants believe that breaches of data privacy and ethics will negatively impact shareholder trust (PwC, 2017). In collecting the information of users or consumers, the line can be inadvertently or maliciously crossed, which poses a potential risk to confidentiality (EY, 2018; Warren, Moffitt, and Byrnes, 2015). Recent accounting studies, including Cao et al. (2015) and Huerta and Jensen (2017), also posit such privacy and security concerns within the domain of accounting Big Data. Hiller and Blanke (2017) worry that the fundamental right to privacy will become brittle and eventually break because of over-reliance on DA. Individual human rights may also be challenged by the complex statistical algorithms used to automate decision-making in business (Liu, Lin, and Chen, 2019). When

[7] For the program details, see https://www.kpmgcampus.com/campus/ourOpportunities#accounting

companies use customer data to improve internal decision-making, they can also sell the data to external parties (Davenport and Kudyba, 2016), hence losing control over how the data will be used (Huerta and Jensen, 2017). Therefore, some legal studies, including Boddie et al. (2017), call for additional disclosure and transparency regarding what information is being collected, how it is handled, and how it is used.

Figure 2. Traditional Audit Steps vs. Integrated Data Analytics Steps



(Retrieved from Deloitte's report: Internal audit analytics: the journey to 2020 insights-driven auditing (Deloitte, 2020))

A recent study by Helbing et al. (2017) strongly warns about the huge threat to the labor market from AI. According to them, in the next 10 to 20 years, around half of today's jobs will be threatened by algorithms, and 40% of today's top 500 companies will vanish. Some transaction-based accounting work will very likely be cut, including data entry, account receivables and payables, inventory count, and bookkeeping solutions (Chandi 2017; Fagella 2020; IMA, 2018). In addition, some opponents believe that the rise of Big Data comes with legal issues (Munoko et al., 2020), including questionable personalized pricing. According to Helbing et al. (2017), price discrimination and a lack of transparent and equal practices will weaken the fair-trade model. A similar kind of alert resonates with the findings in Brown-Liburd et al. (2015), Holt and Lorass (2021), Munoko et al. (2020), and Rose et al. (2017) about the unintended consequences of suboptimal auditor decisions because of accounting Big Data and use of audit analytics.

Other studies, such as those by Andiola, Master, and Norman (2020), Sledgianowski, Gomaa, and Tan (2017), and Watty, McKay, and Ngo (2016), find that accounting professors and departmental chairpersons are still debating how—and to what extent—to incorporate the DA and AI concepts into accounting curriculum. Although some researchers have started to explore incorporating DA assignments in accounting curriculum (Akaaboune et al., 2020), no implementable solutions have been achieved yet.

Key topics for research development

Based on the above debates on DA and AI, we build our survey questions to examine the students' perspectives on the issues and concerns associated with the use of DA and AI in the business world, especially in the accounting profession. All of our survey questions revolve around three key topics:

Topic 1: Will accountants be replaced entirely by DA and AI in the future? Are DA and AI more effective and efficient than human beings? Are people comfortable with the idea that accounting jobs and services are mostly performed by DA and AI in the future?

Topic 2: Are people worried about their jobs being replaced by DA and AI in the future? How would people cope with it? What would they do to protect themselves from being replaced?

Topic 3: Does it raise any ethical, societal, or legal concerns if work is performed by DA and AI instead of human beings?

RESEARCH METHOD

To gain an understanding about how DA and AI will affect the future business environment for accountants, a survey with multiple-choice and open-ended questions was developed and administered among accounting students in a midsized public state university in the United States. During a two-week period between late March and early April in the 2019 spring semester, our investigators approached the accounting students in the lobby of the building of the business school and asked if they would like to anonymously participate in a survey on paper. We invited junior or senior accounting undergraduate students to ensure that the participants had basic knowledge of business and information technology (IT) because the accounting students were required to complete their accounting and business IT courses by their junior year. In particular, from the accounting courses required by the program, including financial accounting, managerial accounting, auditing, taxation, accounting information systems, and advanced accounting, the students should have gained a general understanding of accounting and financial reporting processes, business operational and strategic decision-making techniques, and auditing procedures and processes. The required business IT course, along with the accounting information systems course, should have brushed up on students' knowledge of Big Data, ML, and DA and of the recent development and application in business.

In total, 100 students were invited to participate, and 82 completed the questionnaire. The gender of the respondents was relatively evenly split at 49% male and 51% female students. Survey sheets were collected right after the participants completed the questionnaire in the lobby, and the answers on the papers were manually entered in an Excel file on a computer soon after. The project was approved by the institutional review board of the university.

RESULTS

When asked if they believe that Big Data, DA, and AI will replace the jobs of accountants in the near future, most participants (45 out of 82; 55%) provide a positive answer. In a follow-up question for those who believe that Big Data, DA, and AI will replace the jobs of auditors, the majority believe that the entry-level employees will most likely be replaced. Only one (out of 45) believe that the top-level employees would be replaced (see Figure 3).

When asked if they think that Big Data, DA, and AI may cause ethical issues, such as data privacy, ownership, and transparency, most participants (67 out of 82; 81%) agreed, and only a few (7 out of 82; 9%) disagree. There are also a few participants (8 out of 82; 10%) who do not offer definitive answers. Regarding how concerned they are, most participants (63 out of 82; 76%) rate their concern between moderate and very strong, with only a few stating little concern (see Figure 4).

Figure 3. Results from Q1 and Q2

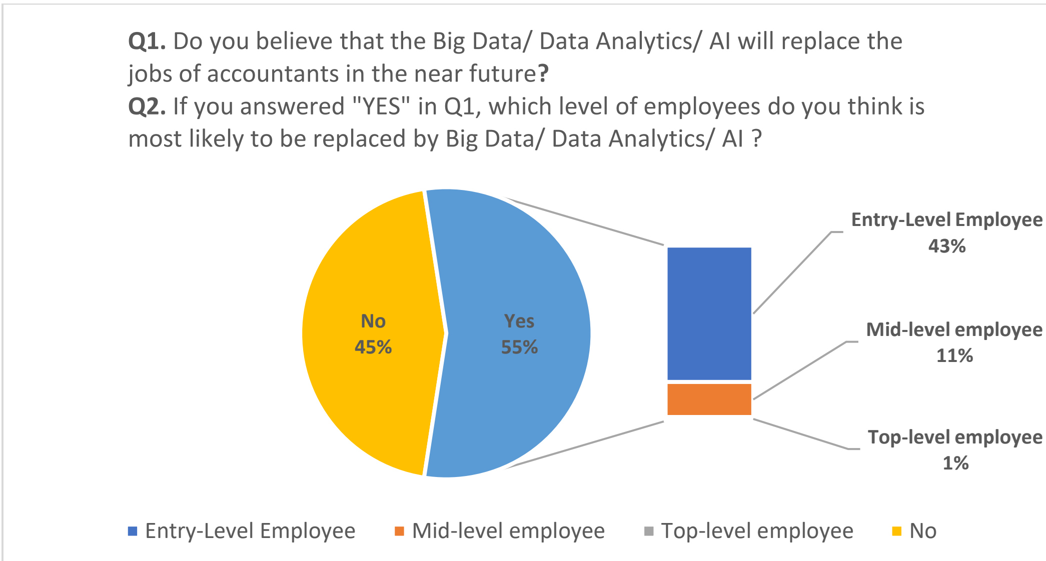
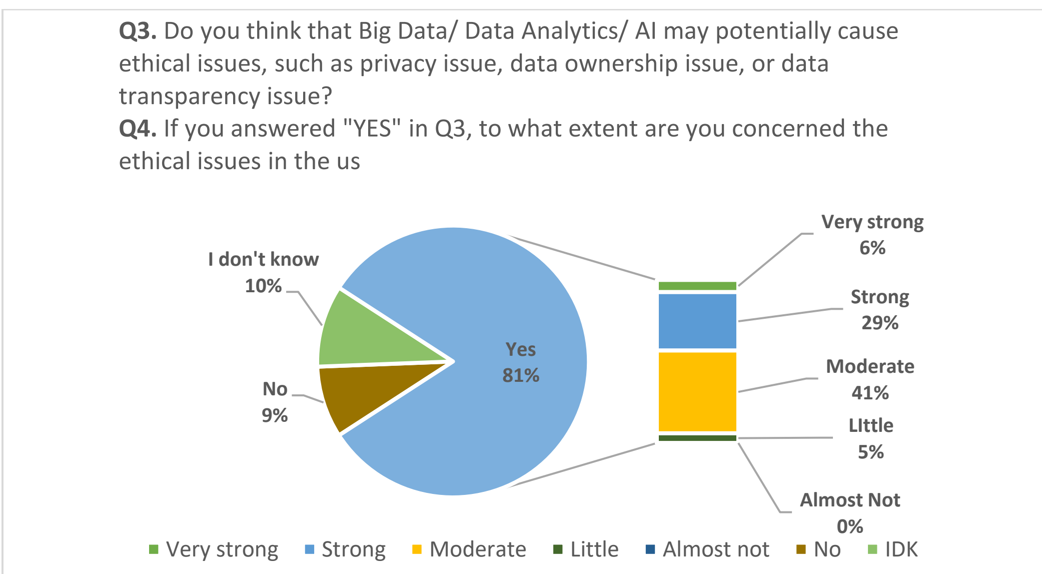
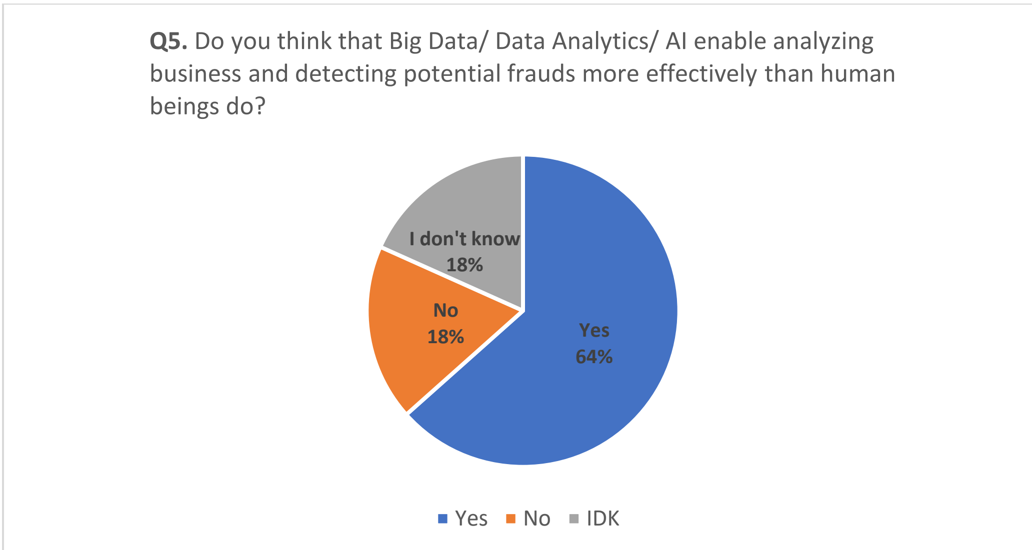


Figure 4. Results from Q3 and Q4



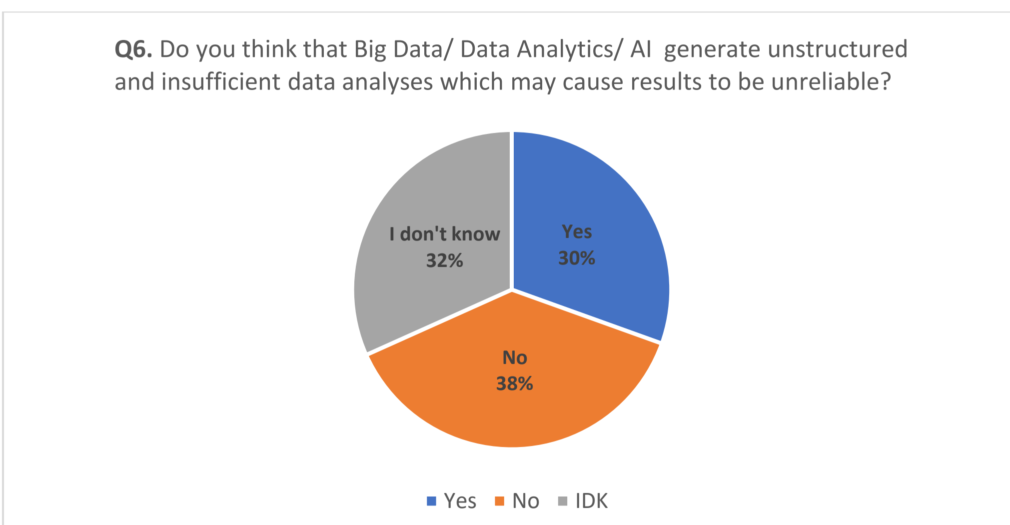
When asked if they think that Big Data, DA, and AI enable analyzing business and detecting potential frauds more effectively than human beings, most participants (52 out of 82; 63%) agree, and only a few (15 out of 82; 18%) disagree. There are also a few participants (15 out of 82; 18%) who do not offer definitive answers (see Figure 5).

Figure 5. Results from Q5



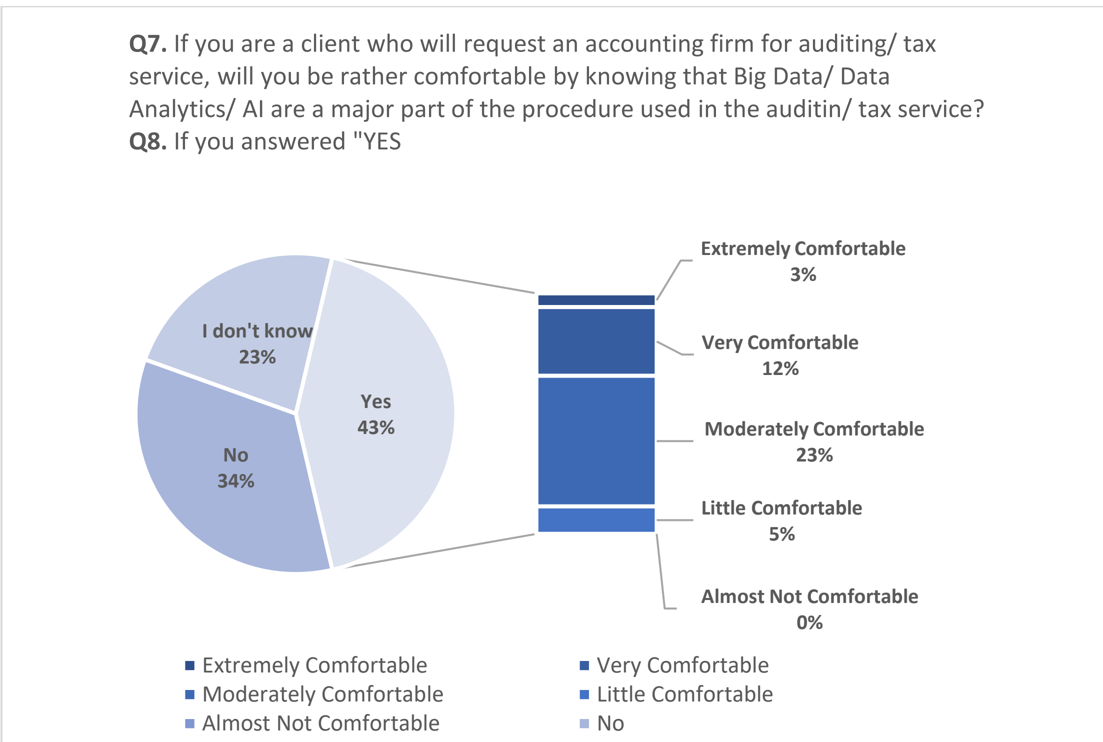
When asked if they think that Big Data, DA, and AI generate unstructured and insufficient data analyses causing results to be unreliable, the participants are split. Here, 25 (30%) participants are positive, 31 (38%) negative, and 26 (32%) are not sure (see Figure 6).

Figure 6. Results from Q6



The participants are then asked if they would be comfortable if a major part of their auditor's or tax practitioner's service was done through Big Data, DA, and AI. Less than half (35 out of 82: 43%) are comfortable with Big Data, DA, and AI being a major part of the procedure used in the auditing/tax service. The rest of the participants are either not comfortable (28 out of 82; 34%) or without a definitive answer (19 out of 82; 23%) (see Figure 7). We ask about the extent of the comfort or discomfort. Here, 31 out of 35 (89%) comfortable participants rate their comfort level from moderately comfortable to extremely comfortable, while 22 out of 28 (79%) uncomfortable participants rate their discomfort level from moderately uncomfortable to extremely uncomfortable (see Figure 8).

Figure 7. Results from Q7 and Q8



When asked if accounting students should be exposed to more analytical and technology-related training while in school than through on-the-job training after school, the majority (53 out of 82; 65%) agree. The rest of the participants are split between being negative (15 out of 82; 18%) and without a definitive answer (14 out of 82; 17%) (see Figure 9).

In light that Big Data, DA, and AI may potentially replace some job functions, the participants are asked if accountants need to become more analytic-oriented to guard their jobs. Most (65 out of 82; 79%) believe so. Only a few participants do not think so (7 out of 82; 9%) or do not have a definitive answer (10 out of 82; 12%) (see Figure 10).

Figure 8. Results from Q9

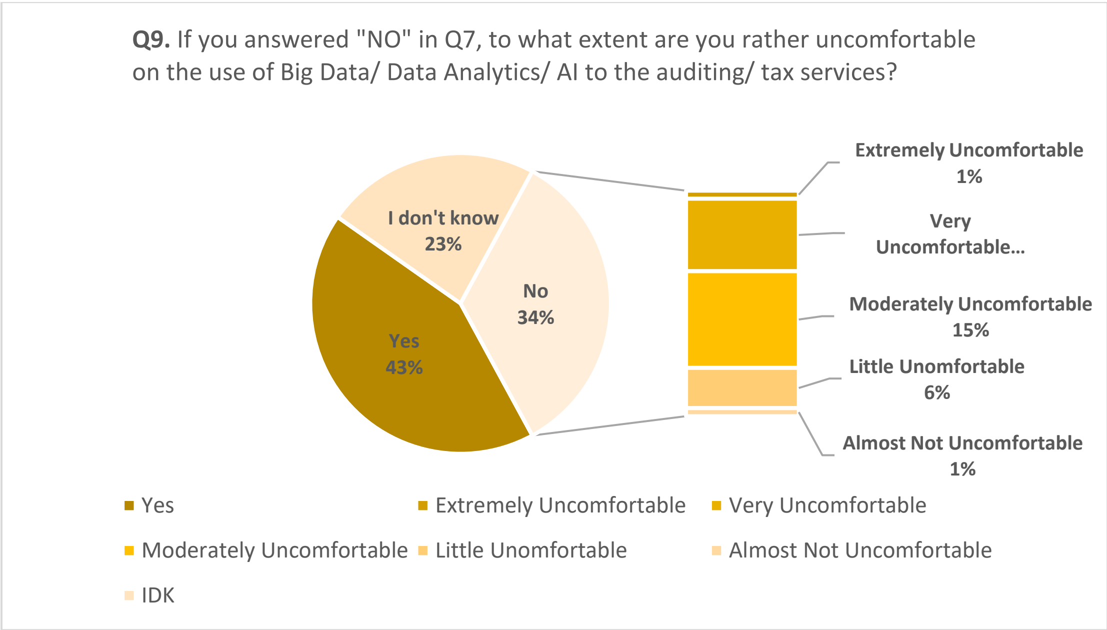


Figure 9. Results from Q10

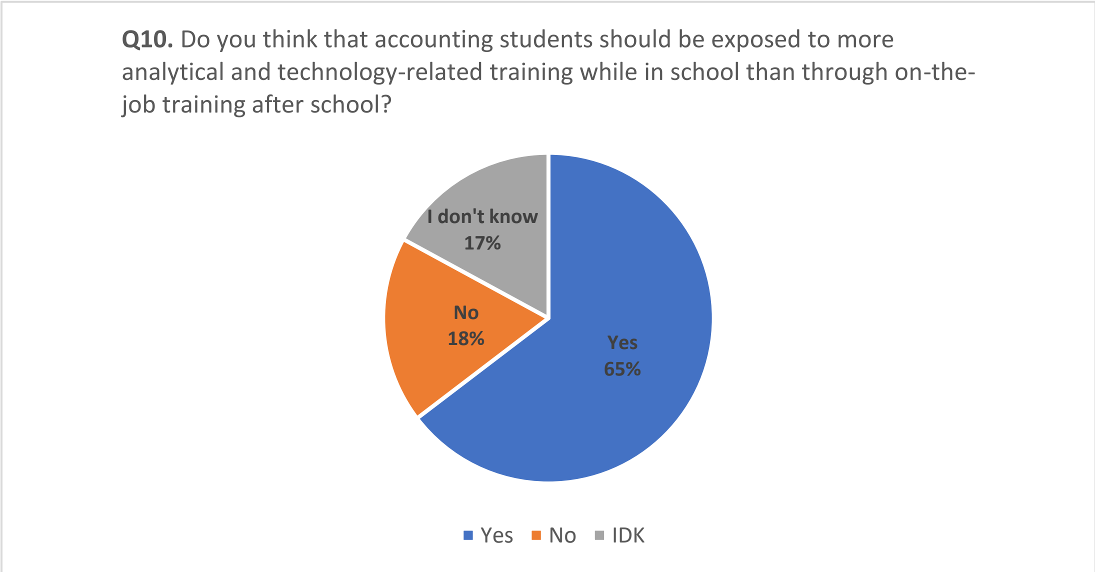
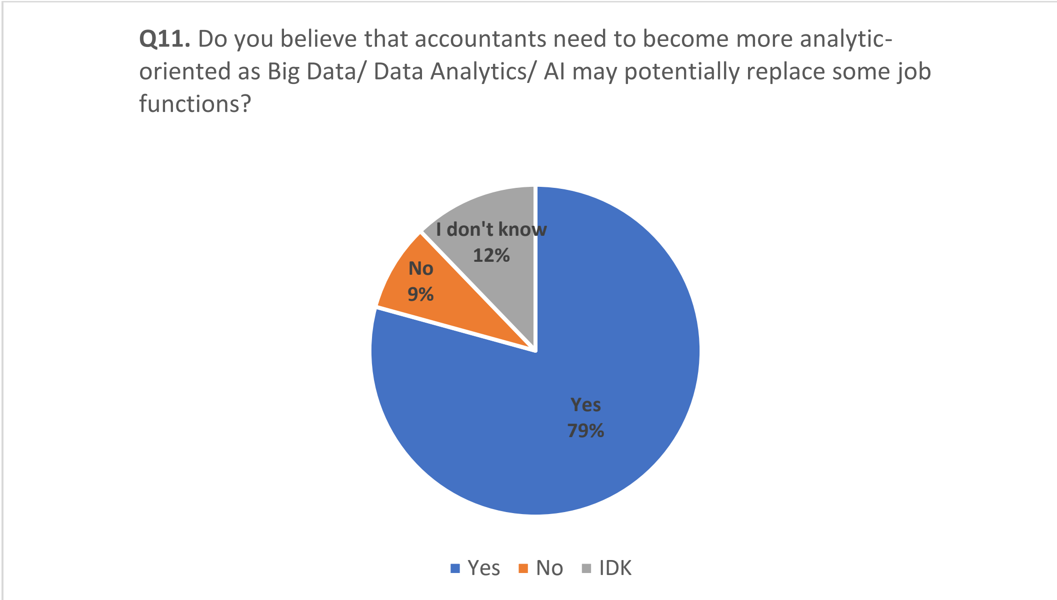


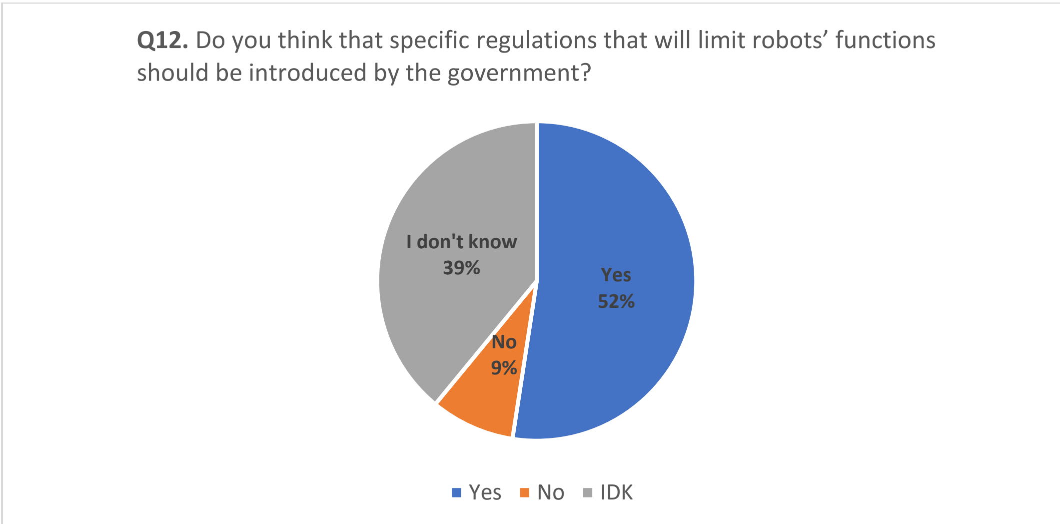
Figure 10. Results from Q11



After reading a paragraph about the possible drawbacks of the databot technology, the participants are asked if the government should limit robots' functions. Most (43 out of 82; 52%) participants believe so. A sizeable portion (32 out of 82; 39%) are not sure. Only a few (7 out of 82; 9%) do not think so. We are interested in knowing how much regulation the positive participants believe the government should have when it comes to limiting robots' functions, so an open-end follow-up question is asked. The answers mostly relate to regulations to ensure data privacy and human job security (see Figure 11).

For those who believe that Big Data, DA, and AI should not replace the jobs in accounting and other business professions, we ask the participants to provide the reasons. Here, 46 out of 82 participants share their comments. Some of them believe that human factors will still be important in the future because "a human can understand complex socio-economic factors that play a role in performance/productivity and, therefore, can judge things differently." Quite a few respondents point out that Big Data, DA, and AI cannot entirely replace humans and that "technology is just a tool." In general, most comments center on the angles such as (1) the human touch cannot be replaced by Big Data, DA, and AI, (2) Big Data, DA, and AI is just a tool to improve human beings' performance, and (3) the impact of a lot of people being replaced by Big Data, DA, and AI can be bad for the economy. Thus, these students' arguments resonate with prior reports conducted by McKinsey (2017a, 2017b).

Figure 11. Results from Q12



As a closure, the participants are asked to provide their general comments about Big Data, DA, and AI replacing accountants and other business professionals. Here, 50 out of 82 participants provide their answers. In general, most participants are quite open about the idea of using Big Data, DA, and AI to assist human beings. Still, many respondents are conservative about the possibility of jobs being replaced by Big Data, DA, and AI, because to them, even though Big Data, DA, and AI excel in information processing, human beings are good at communication and interaction.

CONCLUSIONS AND DISCUSSIONS

With the data-oriented business world quickly approaching, the accounting profession is striving to embrace the new business environment by leveraging the technologies of DA and AI. Because of the tremendous demand for talent, people with expertise in DA and AI will be highly sought after in the job market. At the same time, with the expansion of DA and AI, people are concerned about their job security and data privacy. We are interested in how people, especially those who will be in the middle of evolution to a data-driven world, think about the transition. Therefore, we choose to survey accounting students with questions such as the following: Will the transition be unavoidable? Do they have any concerns about the transition? How will they cope with it? Our purpose is to collect perspectives from them to gain some insights into how students respond to the changes in the future.

The survey results have shown that the students believe the accounting jobs will be replaced by DA and AI, and the replacements will be most likely to happen from the entry-level positions. Most respondents believe DA and AI are more efficient than humans in detecting fraud, but they are also concerned about ethical issues in using DA and AI. Many respondents are comfortable with the idea of using DA and AI to assist human beings; however, they are also very conservative about the possibility of being replaced. Foreseeing the data-oriented future, the students understand the importance of having the skills in DA and AI and prefer being exposed to those technologies while at school rather than at work. The limitations or concerns related to DA and AI, in students' eyes, are the lack of communication and social skills, the threat to human's job security, and the potential breach of data privacy.

Our study offers some observations on accounting students' perceptions about DA and AI and what the technologies might bring about to the business world and accounting profession. Compared with some prior research on the impacts of DA and AI that focus on accounting educators' opinions (Dzuranin, Jones, and Olvera, 2018; Watty, McKay, and Ngo, 2016), we believe that it is critical to examine students' perceptions because they will be in the labor force that will be affected by the transition and should have a built-in interest about what to expect. The current study has also collected opinions from students about DA- and AI-related issues, such as job security, data privacy, and social and ethical complexities. The results will help accounting educators understand how students interpret the changes in skillsets caused by DA and AI and better inform their curriculum planning and design.

In the study, we offer some suggestions on bridging the gap between the supply of qualified candidates and demand of DA and AI skills. Because students are afraid to be replaced by technologies in the future and do have the desire to adapt to the data-oriented job market, companies can look for ways to build infrastructure to help smooth the transition from program to work, such as sponsoring accounting degree or certificate programs to help students build in-demand skills, establishing venues for regular dialogues with accounting educators, and strengthening connections with students by visiting classes and participating in mentoring programs.

We realize that our study has its limitations because the survey was conducted before our student participants had a close-up experience with open AI, especially ChatGPT, starting late 2022. Being impactful to higher education and business in general, ChatGPT is not included in the discussion in the present paper. We do hope that future research can investigate people's perceptions about this new AI technology.

Appendix: Survey Questionnaire

Thank you for agreeing to take part in this important survey to share your perspective on how ***Big Data/ Data Analytics/ Artificial Intelligence*** will affect the future business environments. This survey should only take 5-10 minutes to complete. All your answers will be kept confidential to the maximum level. Thank you!

1. Do you believe that Big Data/ Data Analytics/ AI will replace the jobs of accountants in the near future?
   - ☐ YES
   - ☐ NO
2. If you answered "YES" in Q1, which level of employees do you think is most likely to be replaced by Big Data/ Data Analytics/ AI?
   - ☐ Entry level employees
   - ☐ Manager level employees
   - ☐ Supervising level employees
3. Do you think that Big Data/ Data Analytics/ AI may potentially cause ethical issues, such as privacy issue, data ownership issue, or data transparency issue?
   - ☐ YES
   - ☐ NO
   - ☐ I don't know
4. If you answered "YES" in Q3, to what extent are you concerned the ethical issues in the use of Big Data/ Data Analytics/ AI?
   - ☐ Very Strong Concern
   - ☐ Strong Concern
   - ☐ Moderate Concern
   - ☐ Little Concern
   - ☐ Almost Not Concern
5. Do you think that Big Data/ Data Analytics/ AI enable analyzing business and detecting potential frauds more effectively than human beings do?
   - ☐ YES
   - ☐ NO
   - ☐ I don't know
6. Do you think that Big Data/ Data Analytics/ AI generate unstructured and insufficient data analyses which may cause results to be unreliable?
   - ☐ YES
   - ☐ NO
   - ☐ I don't know

7. If you are a client who will request an accounting firm for auditing/tax service, will you be rather comfortable by knowing that Big Data/ Data Analytics/ AI are a major part of the procedure used in the auditing/tax service?
   - [ ] YES
   - [ ] NO
   - [ ] I don’t know
8. If you answered "YES" in question Q7, to what extent are you rather comfortable on the use of Big Data/ Data Analytics/ AI in the auditing/tax services?
   - [ ] Extremely Comfortable
   - [ ] Very Comfortable
   - [ ] Moderately Comfortable
   - [ ] Little Comfortable
   - [ ] Almost Not Comfortable

9. If you answered "NO" in Q7, to what extent are you rather uncomfortable with the use of Big Data/ Data Analytics/ AI in the auditing/tax services?
   - [ ] Extremely Uncomfortable
   - [ ] Very Uncomfortable
   - [ ] Moderately Uncomfortable
   - [ ] Little Uncomfortable
   - [ ] Almost Not Uncomfortable

10. Do you think that accounting students should be exposed to more analytical and technology-related training while in school than through on-the-job training after school?
    - [ ] YES
    - [ ] NO
    - [ ] I don’t mind
11. Do you believe that accountants need to become more analytic-oriented as Big Data/ Data Analytics/ AI may potentially replace some job functions?
    - [ ] YES
    - [ ] NO
    - [ ] I don’t know

    *Databot technology continues to develop rapidly. Databots can analyze large volumes of information much faster, more effectively, and more accurately than human beings can do. However, there are some drawbacks as well. For example (1) too much information impeding, (2) a predictive ability by limiting certain information processing, (3) inefficient information resulting unreliability, while some critical errors may be detected by human. Some people are concerned that all job functions of auditors might be replaced in the future.

    **Databot is similar to the virtual talking robot. There are* apps and services integrated to modules in its memories which give back to your images, search services and multimedia presentations.

    (The above is summarized based on the information from Databot.us.com)

12. Given the above statement, do you think that specific regulations that will limit robots' functions should be introduced by the government?

    ☐ YES, to what extent on regulation?

    ____

    ☐ NO, why? ____

    ☐ I don't know

13. If you do not think that Big Data/ Data Analytics/ AI should replace the job functions of accounting, or any other business professional, what are the main reasons?

    ____

    ____

    ____

    ____

14. What are your comments on Big Data/ Data Analytics/ AI replacing accountants, or any business professionals?

    ____

    ____

    ____

    ____

Thank you for taking the survey!

[End of Survey]

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THE MASTER OF ACCOUNTANCY: UNDERSTANDING FACTORS INFLUENCING INTENTIONS AND BEHAVIORS TOWARD ACCOUNTING GRADUATE EDUCATION

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THE MASTER OF ACCOUNTANCY: UNDERSTANDING FACTORS INFLUENCING INTENTIONS AND BEHAVIORS TOWARD ACCOUNTING GRADUATE EDUCATION

ABSTRACT

Master of Accountancy (MAcc) program enrollments have declined significantly throughout the United States in the last decade. As the accounting industry is projected to have a shortage of qualified labor entering the market, higher education institutions will be instrumental in supplying well-trained students to the profession. While academics and practitioners may postulate on the factors resulting in MAcc enrollment declines, there is a deficiency of research to support these theories and a lack of investigation on MAcc programs in general. We use the Theory of Reasoned Action (TRA) as a guiding framework to present a proposed conceptual model for analyzing the perceptions of MAcc degrees from key stakeholders that drive the supply and demand of these graduate programs. Research using this proposed framework can provide situational awareness to higher education leaders so they may develop dynamic strategies to effectively lead their programs through a new era in the accounting industry.

INTRODUCTION

The accounting industry is at a critical turning point as there is projected to be a shortage of qualified labor in the accounting market (Iacone, 2022). From the demand perspective, the U.S. Bureau of Labor Statistics (2022) predicted a 6% growth in jobs for accountants and auditors by 2031. Not only is the labor supply in the industry important, but the skills of these entrants are critical to the success of organizations. Societal and demographic shifts are occurring, and the accounting profession must adapt to these changes. Businesses are continually being impacted by technology advances, economic power shifts, urbanization, and demographic changes (PricewaterhouseCoopers, 2015). Artificial intelligence and robotic process automation may eliminate more routine accounting and finance roles in the short-term, but new employment opportunities will be created from the value in the long-term (Gambhir, & Bhattacharjee, 2022). The greater need will be for professionals with more advanced knowledge, skills, and abilities (KSAs) in areas such as data analytics and emerging technologies, as they are viewed as organizational assets for successful operations in the changing environment (Chang et al., 2018; Institute of Management Accountants & Deloitte, 2020).

As the demand for these talented professionals is increasing, the supply of well-trained entrants to the accounting field is diminishing. The primary source of qualified workers to the accounting industry is from higher education institutions. Enrollment trends in accounting programs have caused concern (Gabbin, 2019). Higher education institutions are preparing for the ‘enrollment cliff of 2026’ where the number of college entrants is projected to significantly decline because of the diminishing number of high school graduates (Conley, 2019). COVID-19 is expected to further exacerbate higher education enrollment challenges as online learning at the high school level is projected to lead to more high school dropouts and students taking a gap year before entering higher education (Adams, 2020).

Ultimately, the accounting industry is projected to have a shortage of qualified labor to the market. As the need for more advanced skillsets in accounting continues to evolve, higher education institutions are going to be instrumental in supplying well-trained students to the profession. Specifically, graduate programs in accounting, such as the Master of Accountancy (MAcc), need to ensure their graduates are gaining the advanced knowledge, skills, and abilities to be successful in the labor market. Furthermore, these programs need to influence the attitudes of prospective graduate students with the confidence that they will obtain beneficial KSAs along with career advantages by pursuing a MAcc. Albring and Elder (2020) call for new research on increasing graduate student enrollment in Master of Accountancy programs. To that end, this paper proposes a theoretical model for analyzing the determinants of individuals’ intentions and behaviors towards the MAcc degree. This proposed framework can then be applied to future research to test the model and aid higher education institutions in gaining valuable knowledge on the perceptions of their Master of Accountancy programs.

LITERATURE

Declining enrollments for higher education into accounting programs have been a concern for industries of all types. According to the American Institute of Certified Public Accountants (AICPA, 2022), the number of graduates from undergraduate and graduate accounting degrees in the United States has decreased. Indeed, interest in Master of Accountancy (MAcc) programs has declined as more than 50% of programs reported declines in their MAcc application volume each year from 2016 through 2022 (with the exception of 2020) (Graduate Management Admission Council [GMAC], 2021, 2022). Similarly, MAcc enrollments and graduates have declined as well. To compensate for the deficiency in supply, U.S. firms are hiring more non-accounting majors to fill the skill and labor shortage (AICPA, 2022).

There is little doubt that the accounting industry is headed toward a labor shortage (Iacone, 2022). The profession is aware and is taking measurable steps to resolve the problem. The AICPA and the National Association of State Boards of Accountancy (AICPA & NASBA, 2021a) are responding to the changes in demand by developing the 'CPA Evolution' with the purpose of transforming the Certified Public Accountant (CPA) exam. The goal of the changes is to adapt to new skills and competencies required in the accounting profession, both for what is required today and in the future. The Association to Advance Collegiate Schools of Business (AACSB, 2021), the most prestigious accreditation granted to colleges of business and their accounting departments, updated their accounting accreditation standards to focus on principles-based and outcomes-focused standards. For example, one of the standards focuses on the importance of accounting curriculums to be 'current, relevant, forward-looking, globally oriented, and aligned with program competency goals' (AACSB, 2021, p. 7). Although supplemental accounting accreditation is not required for AACSB-accredited business schools, it still indicates academia's goal to align with industry expectations. Furthermore, the AICPA and NASBA (2021b) created a CPA model curriculum to guide higher education institutions in changes to teaching and curriculum. These guidelines can help prepare graduates with the skills and competencies needed for the advancing marketplace.

Nonetheless, many practitioners and academics speculate why students are not aggressively gravitating toward accounting education and the associated profession which provides stability, upward mobility, and substantial long-term monetary rewards (Deno, 2019). Previous research has analyzed the perceptions of the accounting major and accounting career opportunities by high school and undergraduate college students, both in the United States and internationally

(Ali & Tinggi, 2013; Awadallah & Elgharbawy, 2021; Bidin et al., 2015; Byrne et al., 2012; Crossman, 2017; Dalci & Özyapici, 2018; Hammour, 2018; Kerckhofs et al., 2021; Marriott & Marriott, 2003; Nga & Soo, 2013; Uthman et al., 2019). This research has primarily focused on accounting education as a whole or undergraduate accounting education, but there is less focus on Master of Accountancy programs. Practitioners should be interested in MAcc enrollments due to the advanced skillsets MAcc students can provide. Brink et al. (2016) found that individuals with graduate degrees were more likely to promote and promote more quickly in the Big 4 accounting firms, signifying master's students are more qualified professional entrants.

Application and enrollment data portrayed a decline of enrollment in Master of Accountancy programs (AICPA, 2022; Dawkins et al., 2020; McGrath & Murphy, 2016), yet Albring and Elder (2020) described the decline as anecdotal. While academics and practitioners may postulate on the other factors resulting in MAcc enrollment declines, there is a deficiency of research to support these theories and a lack of research revolving around MAcc programs in general. University leaders need a clear understanding of why MAcc program applications, admissions, and enrollments are declining. If one of the original purposes of requiring 150-credit hours to be licensed as a CPA was to obtain more advanced accounting training in graduate-level courses (Dawkins et al., 2020; Rau et al., 2019), then why is there a significant number of undergraduate accounting students choosing not to pursue the MAcc? Are MAcc programs providing the necessary KSAs and career advantages to be marketable to prospective students and other stakeholders? Rather, would an alternative pathway, such as an MBA or MS-Business Analytics, be a better graduate program for students in order to differentiate their skillset while broadening their career opportunities?

To begin, higher education institution leaders need to gain situational awareness about the current context of their MAcc programs. Piórkowska and Ryńca (2020) articulated the importance of colleges and universities identifying and analyzing their stakeholders' perspectives to stay current with the market and strategically position their programs. Multiple perspectives are needed as different individuals may have varying perceptions of an entity's reputation (Feldman et al., 2014). Uncles (2018) identified employers and students as important stakeholders to be involved in the academic planning process, as their input provides authenticity and discernment to what is important to those who drive the supply and demand of the accounting industry. An institution's or program's reputation is constructed from 'a subjective and collective recognition, perception, attitude and evaluation of higher education institutions among all key stakeholder groups' (Verčič et al., 2016, p.162). The ability to respond to the expectations will impact institutions' legitimacy (Miotto et al., 2020).

THEORY OF REASONED ACTION

The Theory of Reasoned Action (TRA) can be utilized as a guiding framework for adapting a model to the graduate business education arena. TRA provides a rationalized and systematic approach to understanding human behavior and intention by analyzing the determinants of intention (Fishbein, 1979). The Theory of Reasoned Action (Ajzen & Fishbein, 1973; Ajzen & Fishbein, 1980; Fishbein, 1979; Fishbein & Ajzen, 1975; Fishbein & Middlestadt, 1987) is based on the premise that humans are rational individuals that can follow processes. Rational processes guide an individual's intentions and behaviors. The objective of the Theory of Reasoned Action is to understand and predict individuals' behaviors following a systematic process (Fishbein, 1979). Therefore, processes can be utilized in understanding intentions which can then lead to behaviors.

Behavioral Beliefs and Attitudes

Fishbein and Ajzen's (1975) theory predicts that an individual's beliefs and expected outcomes are a function of attitude. Beliefs represent an individual's interpretation or perception of the world, regardless if the viewpoint is objective. Favorable beliefs or perceptions tend to result in positive attitudes whereas unfavorable beliefs or perceptions likely result in negative attitudes. Additionally, expected outcomes are part of an individual's beliefs. The combination of beliefs and evaluation of expected outcomes are referred to as behavioral beliefs (Fishbein & Middlestadt, 1987). While the basis and contexts in which behavioral beliefs are formed may differ, individuals can still develop similar attitudes. The relationship between behavioral beliefs and attitudes has roots in expectancy theory (Fishbein & Ajzen, 1975). Expectancy theory recognizes a relationship between predicted conclusions and an individual's level of satisfaction based on his or her preference for the result (Vroom, 1964).

Furthermore, attitudes provide a deeper level of understanding toward intentions (Fishbein & Ajzen, 1975). Attitude is an individual's feelings, positive or negative, related to his or her own intention or behavior (Fishbein & Middlestadt, 1987). This dimension focuses on an individual's personal feelings. Ultimately, an attitude is the evaluation or perception of feelings toward an intention or behavior. Individuals use association in developing attitudes (Fishbein & Ajzen, 1975). If an intention is associated or perceived as 'good' then individuals may have associated favorable attitudes towards the intention. Conversely, an intention viewed as 'bad' or unfavorable will have unfavorable attitudes.

Normative Belief and Subjective Norms

Along with attitude, the subjective norm is a factor of intention in TRA (Fishbein & Ajzen, 1975). The subjective norm is informed from the normative belief. Normative belief is the perceived pressure from influential individuals to comply with the behavior or intention in question (Fishbein & Middlestat, 1987). In order to create a normative belief, an individual must make inferences on others' perceptions on the intention or behavior. The group of individuals whose opinions are being evaluated can be referred to as influential others, important others, or referent individuals. This group's opinions are relevant to the intention or behavior being evaluated (Ajzen & Fisbein, 1973). The important others can vary based on the context of the behavior or intention, but may include family members, colleagues, supervisors, friends, or a spouse.

The subjective norm is an individual's normative belief about peers' perceptions and his or her resulting motivation to comply with the social pressure (Fishbein & Ajzen, 1975). The pressure of colleagues and society can influence an individual's intentions. Effectiveness of the force can also be impacted by motivation to comply with referents' social pressures. For example, if an individual perceives social pressure to perform an action, the individual is more likely to have the intention to behave accordingly, so long as he or she is motivated to comply with the prevailing sentiment. Ultimately, the subjective norm is the normative beliefs along with the individual's motivation to comply with social pressure which may influence the individual's intentions and behaviors (Fishbein & Middlestadt, 1987). Subjective norms incorporate the concept of social norms (also known as social customs) by which obedience to recognized customs maintains an individual's reputation or creates social welfare (Akerlof, 1980).

Intention and Resulting Behavior

Once again, the objective of the Theory of Reasoned Action is to understand and predict individuals' behaviors following a systematic process (Fishbein, 1979). TRA illustrates a process that can be utilized in understanding intentions which can then lead to behaviors. Intention is comprised of an individual's attitude toward the behavior and the subjective norm (Fishbein & Ajzen, 1975). An individual with positive attitudes toward a behavior and who is motivated to comply with the social pressures to perform the behavior will likely have favorable intentions to execute the behavior. The attitudes, subjective norm, and intention relationship in TRA has roots in Dulany's theory of propositional control. The theory of propositional control (Dulany, 1968) identifies two main components in forming behavioral intentions, expectancy theory (behavior beliefs and attitudes) and the motivation to adhere to the demands of others (normative belief and subjective norm). Fishbein and Ajzen (1975) build upon Dulany's theory to ascribe these principles to the context of social behaviors and social psychology.

The weight in which individuals assign importance to attitudes and the subjective norm in determining intentions can vary (Fishbein & Ajzen, 1975). For example, some individuals may assign more importance to their personal attitude about an intention or behavior rather than the subjective norm's social pressure to comply. Contrarily, individuals may weigh their intentions toward a behavior more heavily on their motivation to comply to society's expectations (subjective norm) rather than their own personal beliefs and attitudes toward the action.

Finally, Fishbein & Ajzen (1975) theorize that intentions toward an action or behavior influence the behavior. If an individual has the intention to perform an action, then the associated behavior is likely to occur. If an individual does not have the intention to execute an action, then the associated behavior will likely not occur. The intention and behavior relationship is woven into other theories in the literature. For example, the concept of self-efficacy in social cognitive theory postulates that a person with high self-efficacy has more confidence in their capability to perform a task and will therefore be more likely to succeed in completing the task (Bandura, 1977). Moreover, goal-setting theory posits a positive relationship between goal setting (developing an intention) and task performance (behavior) (Locke, 1978).

Intentions do not always result in the associated behaviors (Fishbein & Ajzen, 1975). An individual may have an intention to accomplish a goal but may not ultimately exhibit the expectations. Other factors can hinder an individual from behaving as he or she intended, but intention is a primary determinant in behavior. For example, individuals may have intentions to reduce their debt because they have positive attitudes associated with reducing liabilities and they have motivation to comply with the social pressures to achieve financial freedom. However, they may not have appropriate fiscal inflow. Regardless, intention is an important component of behavior. If an individual does not have the intention to perform an act, then they will likely not behave accordingly. Individuals without the intention to reduce their debt will likely not take the associated actions.

The Theory of Reasoned Action has been utilized in other studies in analyzing intentions and behaviors both in education and the accounting industry. Awadallah and Elgharbawy (2021) and Bidin et al. (2005) utilized TRA for analyzing intentions for pursuing undergraduate education in accounting. Alshurafat (2021) combined elements of TRA, social capital theory, and the technology acceptance model to analyze accounting students in Jordan and the factors that influence the use of online learning systems. Fleischman & Valentine (2019) developed a model related to ethical reasoning that involved examining channel stuffing, an unethical practice of boosting profits before reporting periods, that was inspired by TRA. Using TRA as a guiding framework, this model may help identify the factors, and potential relationships between those factors, that influence stakeholders' intentions regarding Master of Accountancy program and degrees.

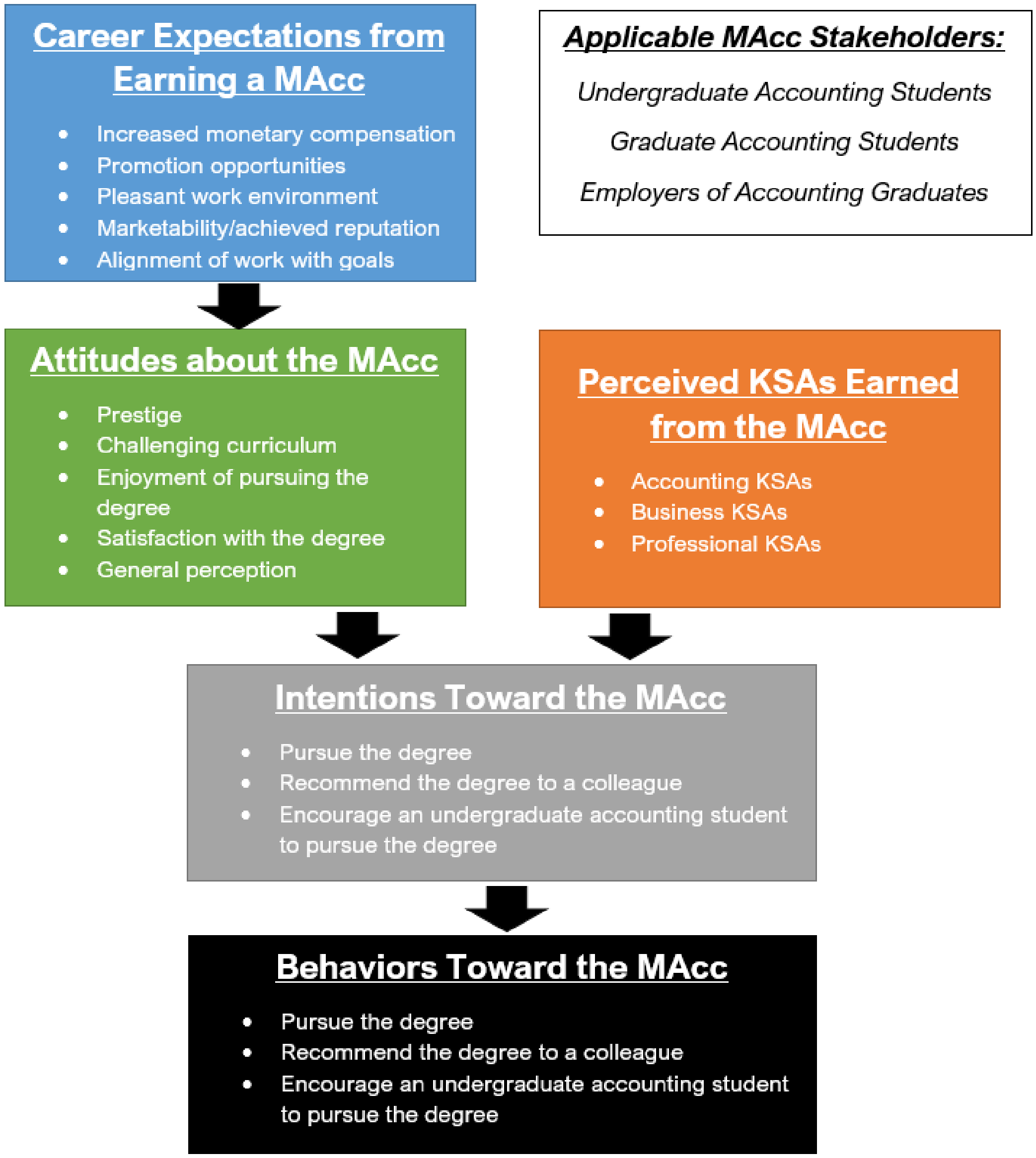
UNDERSTANDING INTENTIONS AND BEHAVIORS TOWARDS MASTER OF ACCOUNTANCY PROGRAMS

To adapt the Theory of Reasoned Action to the context of graduate education in accounting, the Master of Accountancy Theory of Reasoned Action is proposed. The purpose of this framework is to assist higher education institutions in identifying the factors, and potential relationships between those factors, that influence individuals' intentions and behaviors regarding the Master of Accountancy. By doing so, higher education leaders can gain an understanding of the perspectives about their MAcc programs from their most important constituents. This information creates a situational awareness for administrators and faculty to use in strategically positioning and marketing their programs. Figure 1 depicts a conceptual model for understanding the intentions and behaviors of stakeholders toward Master of Accountancy (MAcc) programs.

The model can be applied to key stakeholders that drive the supply and demand of MAcc students: undergraduate accounting students, graduate accounting students (MAcc students), and employers of accounting graduates. These stakeholder groups' viewpoints are integral to understanding the perceptions of MAcc programs and degrees. Undergraduate accounting students represent the supply of accounting graduates to the workforce and the primary supply of entrants to MAcc programs. Graduate accounting students (MAcc students) represent an important viewpoint of MAcc programs and degrees from current participants. Finally, employers represent the demand for accounting graduates as they hire accounting students (both graduate and undergraduate). Other potential stakeholders could include individuals

Figure 1

A Framework for Understanding Intentions and Behaviors Related to Master of Accountancy Programs



Note. Adapted from the Theory of Reasoned Action (Ajzen & Fishbein, 1973; Ajzen & Fishbein, 1980; Fishbein, 1979; Fishbein & Ajzen, 1975; Fishbein & Middlestadt, 1987).

without an academic background in accounting wanting to transition into an accounting role or individuals needing to attain the educational requirements to sit for the CPA exam. For the purposes of this paper, the focus is on the primary stakeholders driving the supply and demand for the degree: undergraduate accounting students, graduate accounting students, and employers of accounting graduates.

Career Expectations from Earning a MAcc

Fishbein and Ajzen's (1975) theory predicts that an individual's beliefs and expected outcomes impact attitude. Similarly, our framework proposes that career expectations impact attitudes. A career expectation can refer to a person's achievable future career prospects (Ahmad et al., 2019). Some examples of career expectations include monetary compensation, achieved reputation, and alignment of work with personal goals or preferences (Ahmad et al., 2019; Oettingen & Mayer, 2002). If an undergraduate accounting student perceives a career benefit from pursuing a MAcc, such as increased earning potential, then the student may have a more positive attitude toward the degree. Graduate accounting students that perceive they will have more marketability in their careers by earning a MAcc will likely have more promising attitudes toward the degree. Employers of accounting graduates that have achieved early career promotions from earning the MAcc may have encouraging attitudes about the degree. Conversely, individuals with negative career expectations from earning a MAcc such as an unpleasant work environment or minimal career advantages may have unfavorable attitudes about the degree. We propose the following relationship regarding career expectations and attitudes toward MAcc programs.

P1: Positive career expectations from earning a MAcc degree will lead to a more positive attitude toward the degree.

Attitudes about the MAcc

Like TRA, the proposed framework postulates that the intentions toward Master of Accountancy programs or degrees are comprised of stakeholders' attitudes toward the degree and the perceived KSAs developed from earning the degree (derived from the subjective norm). Stakeholders' feelings towards the degree influence their attitudes and therefore their intentions. If pursuing a Master of Accountancy is associated as 'good' then individuals may have favorable attitudes about the degree and positive intentions. Likewise, dissenting connotations toward the MAcc may create unfavorable attitudes and results in negative intentions toward the degree. The relationship between attitudes and intentions would be similar among the applicable

MAcc stakeholders. If undergraduate accounting students have good attitudes toward MAcc programs or degrees, then they may have positive intentions to pursue the degree. Graduate accounting students and employers with supportive attitudes about the degree may be more likely to recommend the degree to a colleague or friend (a positive intention).

Marriott and Marriott (2003) conducted a study regarding students' attitudes toward the accounting profession at the beginning and end of their undergraduate collegiate academic careers. The study used an Accounting Attitude Scale (Nelson, 1991) in assessing students' attitudes regarding the profession. During the beginning of their programs of study, students had positive attitudes regarding the accounting profession, however, attitudes about the profession were significantly lower by the end of their programs (Marriott & Marriott, 2003). Interestingly, the increased exposure to the accounting profession during their tenure as students negatively impacted their attitudes. The speculated reasons for the decline in attitudes included students finding the coursework boring or the career prospects less alluring than expected.

P2: Positive attitudes toward MAcc degrees lead to positive intentions toward the degree.

Perceived KSAs Earned from the MAcc

Next in the framework, the perceived KSAs earned from the degree and the associated social pressure to possess those KSAs can influence a MAcc stakeholder's intentions related to the Master of Accountancy. This model embraces behavioral beliefs and subjective norms from TRA but incorporates an important element surrounding the purpose of higher education (the attainment of knowledge, skills, and abilities). If an undergraduate accounting student perceives they will acquire KSAs from the Master of Accountancy that are desired by important others (such as employers, peers, or family members) and they are motivated to comply with their desires, then the student may have more positive intentions towards pursuing the Master of Accountancy. Graduate accounting students or employers of accounting graduates that perceive that the Master of Accountancy develops beneficial KSAs and there is industry demand for individuals to have those KSAs will likely recommend the Master of Accountancy to friends or colleagues. The AICPA (2018) developed a pre-certification core competency framework which outlines the KSAs needed for an individual entering the accounting profession. The competencies are categorized in three different areas (accounting, business, and professional) and include KSAs such as technology and tools, measurement analysis and interpretation, strategic perspective, and project management.

According to the AICPA and NASBA (2021b), graduate programs in accounting can take an in-depth exploration into areas discussed in undergraduate accounting education. One of the original purposes of shifting the CPA licensure educational requirement from 120 to 150 credit hours was for CPAs to have completed a graduate program where the additional education would create career-ready graduates that can undertake greater responsibilities more rapidly in their careers (Dawkins et al., 2020). The additional 30 hours of graduate education may not be producing the desired advanced career readiness and skills of graduates, creating a master's level accounting skill gap similar to the deficiencies that have been identified in accounting education as a whole.

While ideally obtaining a Master of Accountancy should be the intention of anyone wanting to obtain the advanced skillsets employers are wanting, an additional 30-credit hours is only required for those pursuing the CPA licensure (Rebele & St. Pierre, 2019). Those not pursuing the CPA license have no higher educational requirements obligating them to additional education. Dawkins et al. (2020) proposed that 30 credit hours, may not be sufficient enough education to foster the complexity of needs for long-term careers while still balancing CPA exam readiness. Graduate education in accounting should build upon a broad undergraduate base to create specific graduate attributes, yet this goal of graduate differentiation may not be coming to fruition (Lansdell et al., 2020; Yap et al., 2014). Based on the aforementioned literature, we propose the following relationship between KSAs and intentions toward the MAcc degree:

P3: Individuals that perceive students will acquire KSAs from the MAcc that are desired by important others (such as employers) will have more positive intentions toward the degree.

Intentions Toward the MAcc

The proposed framework focuses on MAcc program stakeholders' intentions regarding the degree. The specific intention toward the MAcc could vary based on the stakeholder. Undergraduate accounting students may have intentions related to the pursuit of a MAcc degree or program. Graduate accounting students or employers of accounting graduates may have intentions related to recommending the degree to colleagues or family members. Most importantly, higher education institution administrators would be interested to know undergraduate students' intentions regarding pursual of the degree, as they represent the target market for recruitment and enrollment into a MAcc program. The perspectives of graduate accounting student and employers are also important as they can be influential to prospective MAcc applicants. Nonetheless, understanding these three stakeholders' intentions provides a situational awareness regarding the perceived value of the degree.

Fishbein & Ajzen (1975) postulate that intentions toward an action are a result of the attitudes towards the behavior and the subjective norm. Similarly, we propose that intentions toward a MAcc are based on stakeholders' attitudes toward the degree and their perceptions that MAcc students will develop the KSAs that are desired by important others and are motivated to comply with those expectations. Undergraduate accounting students with enthusiastic attitudes about the program and who are motivated to attain desirable KSAs that are important to influential others (such as employers), will likely have intentions to pursue the degree. Likewise, current MAcc students who have enjoyable attitudes about the degree they are pursuing and also perceive they are obtaining beneficial KSAs that employers value may have positive intentions to recommend the MAcc to an undergraduate accounting student. Employers of accounting graduates who have positive attitudes about the degree and believe the MAcc is developing well-skilled graduates may have intentions to recommend the MAcc to undergraduate accounting students or colleagues.

Each MAcc program stakeholder may have varying levels of importance they assign to attitudes and perceived KSAs in developing intentions toward the degree. Undergraduate accounting students may place more importance on their desires to obtain KSAs they believe employers want them to attain and less importance on their personal attitudes on the degree when developing intentions to pursue the MAcc. Graduate accounting students and employers may weight their personal feelings and attitudes as a more influential factor than the perceived skills developed due to any personal association or affinity they may have with the degree.

P4: Positive attitudes and perceptions that students will acquire KSAs from the MAcc that are desired by important others (such as employers) will have more positive intentions toward the degree.

Behavior Toward the MAcc

The final relationship in the model is between intentions and behaviors. Intentions to perform an action influences behavior (Fishbein & Ajzen, 1975). For our model, a MAcc stakeholder's intentions toward the Master of Accountancy will directly influence behaviors toward the degree. If an undergraduate accounting student has positive intentions to pursue the MAcc, then the student may have positive behaviors in applying and enrolling in a MAcc program. Graduate accounting students or employers of accounting graduates who have positive intentions to recommend the degree to a friend or colleague will likely perform the associated behavior of recommending the program. The same relationship exists with negative intentions and negative behaviors. An undergraduate accounting student that does not plan to pursue the degree will likely not perform the behavior of applying for the program.

Fishbein and Ajzen (1975) clarify that intentions may not result in the associated behavior as other elements can result in a different behavior than the intention. For example, an undergraduate accounting student may have the intention to pursue the Master of Accountancy but may not have the financial resources necessary to pursue the degree. Because of the potential interfering elements between intentions and behaviors, this proposition emphasizes intentions and the proposed factors that inform intentions: career expectations, attitudes, and desired KSAs.

P5: Positive intentions toward the MAcc lead to positive behaviors toward the degree.

DISCUSSION AND IMPLICATIONS

One of the predominant MAcc stakeholders that is likely to consider the aforementioned factors in developing intentions to pursue the Master of Accountancy are undergraduate students (especially accounting students). According to this proposed model, undergraduate accounting students are rational and will systematically use or process information available to them to develop intentions and associated behavior decisions when determining the value of the Master of Accountancy in their future careers. Attitudes regarding the Master of Accountancy aid in understanding an individual's intentions regarding the Master of Accountancy. Furthermore, the individual's career expectations from earning the MAcc also impact attitudes. From the subjective norm perspective, an individual's intention to value the Master of Accountancy may be a factor of the social pressure for an individual to obtain specific KSAs for a successful career in the accounting industry. Ultimately, 'people will intend to perform a behavior when they evaluate it positively and when they believe that important others think they should perform it' (Fishbein, 1979, p. 67). In this case, an undergraduate accounting student's intention to pursue a Master of Accountancy may be based on beliefs about the career outcomes from earning the degree, his or her attitudes, and perceived social pressure to earn the distinction and the knowledge, skills, and abilities from the degree.

Other MAcc program stakeholders, such as MAcc students and employers of accounting graduates, may utilize the framework in the same method. Instead of the pursing the MAcc, graduate accounting students or employers of accounting graduates may utilize this framework when making the determination of their intentions to recommend a MAcc degree to their colleagues or undergraduate accounting students. Regardless of the MAcc program stakeholder, this proposed model provides a framework for future research to identify the factors, and potential relationships between the determinants, that influence individuals' intentions and behaviors related to the Master of Accountancy.

Additionally, focusing on intent and the influencing factors, rather than the behavior, provides a more focused analysis on the perceived value of the Master of Accountancy degree. If an undergraduate accounting student does not have the intention to pursue the program, then financial concerns would not have an impact on the associated behavior of pursuing the degree. Higher education leaders first need to gain a situational awareness on the perceived value of the program before addressing any barriers that could result in changes from intentions to behaviors. If universities find that students have intentions to pursue the degree, but the enrollment data provides contradictory evidence, then more research can be conducted on barriers to enrollment. The focus of this framework is understanding stakeholders' intentions related to the degree and the factors influencing their intentions.

Cattaneo et al. (2016) emphasized the need for public institutions to proactively manage the attractiveness of their programs with consideration for stakeholders' viewpoints. Even AACSB recognizes the importance of stakeholders' perspectives, as the accreditation standards expect documented involvement from stakeholders (Bailey, 1994). Bailey (1994) attested that 'quality cannot be determined independent of stakeholder input and involvement' (p.5). Consumerization is now part of the academic climate. Service-oriented industries must rely on stakeholders' expectations and must be reactive to their emerging desires (Uncles, 2018). Stakeholder evaluations are the basis for understanding the perceived reputation and legitimacy of higher education institutions (King & Whetten, 2008). Miotto et al. (2020) emphasized the importance of reputation and legitimacy in maintaining a competitive advantage for higher education institutions. Maintaining legitimacy will be crucial for higher education institutions to attain funding, enhance stakeholder relationships, and avert public scrutiny (Deephouse & Carter, 2005). 'Evaluating legitimacy and reputation, as well as understanding the relationship between them in public universities, can provide useful insights for these academic institutions' managers to achieve a highly competitive position within the Higher Education Industry' (Miotto et al., 2020, p. 345).

Furthermore, higher education institutions must embrace entrepreneurial management styles for program management and student recruitment to be able to maintain enrollment (El Nemar et al., 2018). New management techniques, innovative strategic plans, and specialized marketing tactics are all essential to enduring the unfavorable outlook for higher education with the pending enrollment crisis (Miotto et al., 2020). Being forward thinking and future oriented are skills administrators need in navigating the dynamic marketplace (Park, 2021). To be competitive, colleges and universities will not only need to provide quality service in an expansive and transformative learning experience, but also be able to confidently market or communicate the value proposition to society (Miotto et al., 2020). Vikhanskii (2017) detailed the essence of strategy, which entails understanding conditions and consequences. Awareness of stakeholders' perspectives is critical to understanding conditions and the environment. Strategy itself is the adjustments and adaptations to the environment. Recognizing and reacting to stakeholders' perspectives and changes in the market will be imperative to legitimacy and overall success for both higher education institutions and accounting programs (Bailey, 1994).

CONCLUSION

The accounting industry is in a state of transition. 'A primary goal for professors in academia is to facilitate the career success of their students by providing them with the necessary subject knowledge, skills, experience, and confidence' (Schoenfeld et al., 2017, p. 109). Just as accounting firms institute initiatives to remain seen as a legitimate career opportunity for students, leaders of higher education institutions need to continually evaluate the quality, relevancy, and sustainability of their MAcc programs in the dynamic accounting profession to maintain legitimacy to its stakeholders (Dawkins et al., 2020; Durocher et al., 2016).

For higher education institutions to remain relevant, students must perceive value in continuing education. The concept of private economic benefit notes that individuals pursue higher education to obtain superior jobs and pay which will lead to a higher quality lifestyle (Astin,1984). For students to pursue continuing education, they must discern that there will be future rewards associated with additional education (Kerby et al., 2014). Moreover, students perceive value when they see advanced resources, an engaging learning environment, and an expanding network of colleagues (Uncles, 2018). Higher education institutions must provide a valuable service to students by producing engaging and current curriculum while marketing the programs' value to influential stakeholders.

Ultimately, the accounting industry is headed toward a deficiency in the supply of CPAs which creates a challenge for employers to find new talent (Rau et al., 2019). To compensate for the reduced supply, U.S. public accounting firms are hiring more nonaccounting majors to fill the skill and labor shortage (AICPA, 2022). 'As industries are transformed by rapid innovation and advancement, no job is safe from obsolescence or radical restructuring. The need for lifelong learning looms large' (Vanhonacker, 2021, p. 2). Accounting programs, specifically Master of Accountancy programs, must utilize this time of declining enrollment and industry change as an opportunity to reposition before more future potential declines because of the 'enrollment cliff of 2026.'

There is a deficiency of clear evidence for why students are declining to pursue graduate education in accounting. Academic leaders need to be equipped with this information to be effective in strategically aligning their programs and marketing the degree as an effective return on investment (Education Advisory Board, 2019). Research utilizing this conceptual framework for understanding factors that affect intentions and behaviors towards MAcc programs can provide a situational awareness about Master of Accountancy programs to higher education institutions via understanding stakeholders' career expectations, attitudes, perceived KSAs, and intentions toward the degree. This information can be used to aid in the understanding of the reasoning behind recent MAcc enrollment challenges and then help colleges and universities to strategically position and market their Master of Accountancy programs to align with the wants and needs of their constituents, accounting employers and students. The intended use of this model is differentiated from other studies in that the purpose is to examine the Master of Accountancy, not accounting education in general or undergraduate accounting education. While focused on Master of Accountancy programs and degrees, this model could also be adopted by other business graduate degrees, such as the MBA.

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