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Cost of Capital and Valuation: Applications with Finite Cash Flows

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The paper demonstrates the application of the cost of capital approach to valuation when cash flows have finite lives. It is shown that under more general conditions with respect to debt policy and pricing, the popular valuation approach that favors the textbook cost of capital becomes problematic and breaks down when debt is set as a fixed amount. Then, only the adjusted present value (APV) method yields consistent valuations. This limitation as well as the extensive use of a fixed debt policy, evidenced by academic studies and observation, justifies more thorough coverage of the APV method. Attention to the limitations of finding value by discounting relevant cash flows at the WACC and greater exposure to the APV method would provide students with a better grasp of valuation techniques.

INTRODUCTION

If asset valuation is at the core of finance, then the cost of capital is one of the most important topics taught in finance. Yet its coverage in most textbooks leaves students with a simplistic view of how it should be applied under different patterns of cash flows and debt policies.[1] Several articles have attempted to provide more nuanced applications of the cost of capital in valuation without, however, achieving a sufficiently comprehensive coverage of more realistic conditions. Taggart (1991) shows that consistent expressions of cost of capital can be derived and used in the valuation of perpetual and finite cash flows when debt is set as a ratio of firm value and debt is issued at par. In the particular case of perpetual cash flows, Oded and Michel (2007) show that the methods of adjusted present value (APV), capital

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[1] Usual omissions are the specification of the debt policy of the firm and the pattern of cash flows. For example, Clayman, Fridson, and Troughton (2008), Damodaran (2006), and Brigham and Daves (2013) propose the correct equations for the levered equity beta but are not clear about the debt policy.

cash flows (CCF), cash flows to equity (CFE), and free cash flows (C) produce consistent valuation results when debt is set as a ratio of firm value.[2]

Usually left out are applications in the case of finite cash flows when debt is not set as a ratio of value or when debt is not priced at par value. Thus, students may not have sufficient understanding of the significance and the analytics of proper rebalancing and valuation of debt when these conditions hold. They may also fail to recognize under which conditions it is possible to obtain consistent valuation across alternative approaches, that is, those relying on a composite cost of capital versus the APV approach.[3] The learning outcome can then deviate from the learning goals related to valuation. Thus, inadequate exposure to valuation under a broader set of conditions has implications from an assurance of learning standpoint.

This paper aims toward closing this gap by extending valuation applications to the case of finite cash flows when debt is not priced at par. An example with finite cash flows and proportional debt is presented first in order to provide a contrast in the analytics that are required to obtain consistent valuations across different methods in the case of fixed debt (priced at or not at par). The paper derives and discusses the expressions for the various specifications of the cost of capital under proportional and fixed debt, and then uses numerical examples to demonstrate the feasible and correct application of the cost of capital specifications and the APV method in order to yield valuations that are consistent with financial theory.

For greater relevance to practice, the applications assume a market interest rate for debt other than the risk-free rate which is frequently used in the derivation of cost of capital specifications and examples. Finally, the Capital Asset Pricing Model (CAPM) and the Modigliani-Miller (MM) expressions are applied to the numerical examples in order to estimate discount rates.

The remainder of the paper is organized as follows. Section 2 presents a summary of the various discounts rates and the corresponding cash flows that should be used in valuation. Section 3 presents the expressions of the cost of capital and their applications when cash flows have a finite life and debt is set proportional to firm value. Section 4 presents the expressions of the cost of capital and numerical applications when cash flows have finite lives and debt is set as a fixed amount. Section 5 summarizes the paper and draws its main conclusions.

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[2] Fernandez (2007) develops expressions for the WACC when debt is set as a ratio of the book values of debt and assets, but his numerical example demonstrates that in such cases the WACC can be computed only after the value of the firm has been estimated.

[3] For example, Brealey, Myers, and Allen (2011) as well as Brigham and Daves (2013) emphasize the need for rebalancing to maintain a constant WACC and offer examples of the APV method. Neither textbook, demonstrates the equivalence of these valuation approaches under different sets of assumptions about the duration of cash flows, the debt financing method, or the case of debt not priced at par.

DISCOUNT RATES AND CASH FLOWS

The cost of capital literature has identified four composite discount rates that can be used to estimate the firm's value from the assets or the capital claims side. On the assets side, k_a is the average portfolio expected rate of return of the firm's assets. This rate is used to discount the total cash flow (TCF) of assets, that is, the unlevered after-tax free cash flow, C, plus the interest tax shields, ITC. When the Modigliani and Miller (1963) valuation equation $V = V_u + V_{ITS}$ holds, the composite rate k_a is the weighted average return of the unlevered rate of return, k_u, and the rate that discounts the interest tax shields, k_{ITS}. We can also derive the composite rate k as a function of the rates k_u and k_{ITS}. The rate k is the Modigliani-Miller version of the overall cost of capital (k_o) and discounts the unlevered after-tax free cash flow.

On the capital claims side, the composite rate k_c is the cost of capital estimated as the portfolio average of the expected rate of return of equity, k_e, and the expected rate of return of debt, k_d. The composite rate k_c is used to discount the capital cash flow (CCF) of the firm, which represents the total cash flow to both the equity holders and debt holders, and equals C plus ITS. Since the TCF and CCF are equal and the value of assets must equal the value of capital claims, the composite rates k_a and k_c are also equal. Finally, the composite rate k_o is the after-tax overall cost of capital, also known as the textbook weighted average cost of capital (WACC). The rate k_o is used to discount the unlevered free cash flow stream, C. Exhibit 1 explains the notation that is used in the rest of the paper.

Exhibit 1. Explanation of Notation.

r_f	Risk-free rate
r	Coupon interest rate
k_d	Market interest rate
k_e	Cost of equity
k_u	Cost of unlevered cash flows
k_{ITS}	Discount rate of interest tax shields
k_a	Asset portfolio cost of capital
k_c	Capital claims cost of capital
k_o	Overall cost of capital – WACC
k	Overall (MM) cost of capital
β_u	Unlevered beta
β_d	Debt beta
β_e	Equity (levered) beta
β_a	Asset portfolio beta
β_c	Capital claims portfolio beta
EP	Equity Premium ($r_m - r_f$)
T	Corporate tax rate
C	Unlevered free cash flow
V	Value of free cash flows to firm
V_u	Value of unlevered cash flows
V_{ITS}	Value of interest tax shields
D	Market value of debt
B	Book value of debt
E	Market value of equity
L	Debt ratio, D/V

FINITE CASH FLOWS AND PROPORTIONAL DEBT

Each period, the firm is expected to maintain a level of debt whose market value is a constant ratio L of the firm's beginning-of-the-period value. The expected value of the uncertain after-tax unlevered cash flow, C_t, is allowed to vary across time. A finite cash flow life implies that the value of the firm is not necessarily constant in each period. Hence, a constant debt ratio L implies that the expected market value of debt varies across time and the firm must rebalance its debt by issuing new debt or by retiring old debt. The business risk is assumed constant, determined by the firm's investments at t = 0, and thus the expected unlevered rate k_u remains constant in all periods. Constant business risk and constant debt ratio (that is, constant financial risk) imply that the expected rates k, k_e, k_d and the coupon rate of interest, r, remain constant during the duration of the cash flows. Since firm value is uncertain in each period, the appropriate discount rate of the interest tax shields is the unlevered cost of capital k_u.[4]

Exhibit 2 presents expressions for the various discount rates and their respective betas as well as the value of the firm and value of equity when cash flows have finite life and debt is set as a ratio of firm value. Derivations appear in Appendix A.

Exhibit 2. Expressions for Fixed Cash Flows and Proportional Debt (Constant Ratio).

Panel A: Expressions for Discount Rates and Betas		Panel B: Value Expressions	
$k = k_u - Tk_d \frac{D}{V} = k_u\left(1 - \frac{Tk_d}{K_u}\left(\frac{D}{V}\right)\right)$; *when* $r = k_d$	(2A.1)	$V_0 = \sum_{t=1}^{n} \frac{C_t}{(1+k)^t}$	(2B.1)
$k_0 = k_u - Tk_d \frac{D}{V} = k = k_c - Tk_d \frac{D}{V}$; *when* $r = k_d$	(2A.2)	$V_0 = \sum_{t=1}^{n} \frac{C_t}{(1+k_0)^t}$	(2B.2)
$k_a = \frac{V_{u,t}}{V_t} k_u + \frac{V_{ITS}}{V_t} k_u = k_u = k_c$	(2A.3)	$V_0 = \sum_{t=1}^{n} \frac{C_t + TrB_{t-1}}{(1+k_a)^t}$	(2B.3)
$k_c = k_e \frac{E}{V} + k_d \frac{D}{V} = k_a - k_u$	(2A.4)	$V_0 = \sum_{t=1}^{n} \frac{C_t + TrB_{t-1}}{(1+k_c)^t}$	(2B.4)
$k_e = k_u + (k_u - k_d)\frac{D}{E}$	(2A.5)	$V_0 = \sum_{t=1}^{n} \frac{C_t}{(1+k_u)^t} + \sum_{t=1}^{n} \frac{TrB_{t-1}}{(1+k_u)^t}$	(2B.5)
$\beta_c = \beta_e(1-L) = \beta_a = \beta_u$; *when* $\beta_d = 0$	(2A.6)	$E_0 = \sum_{t=1}^{n} \frac{CFE_t}{(1+k_e)^t}$	(2B.6)
$\beta_{c,t} = \beta_e(1-L) = \beta_d L = \beta_a = \beta_u$; *when* $\beta_d \neq 0$	(2A.7)		
$\beta_e = \beta_u \frac{V}{E}$; *when* $\beta_d = 0$	(2A.8)		
$\beta_e = \beta_u \frac{V}{E} - \beta_d \frac{D}{E}$; *when* $\beta_d \neq 0$	(2A.9)		

[4] Discounting the interest tax shields at k_u assumes that debt rebalancing is continuous (Harris and Pringle, 1985). However, Brealey, Myers and Allen (2011) point out that beginning-of-period rebalancing has a negligible effect on the results. Miles and Ezzell (1980) propose that the first period interest tax shield is certain and should be discounted at k_d whereas future interest tax shields are uncertain and should be discounted at k_u.

Several observations are worth noting in relation to the expressions in Exhibit 2. First, when debt is proportional to firm value, the expression for the rate k is the same for perpetual and finite cash flows (see also Taggart, 1991). Second, when both the unlevered cash flows and interest tax shields are discounted at k_u, the latter is also equal to the composite rates k_a and k_c. Thus, when k_u is assumed constant over time, the rate k_a is also constant notwithstanding the time-varying weights $V_{u,t}/V_t$ and $V_{ITS,t}/V_t$ of equation (2A.3) in Exhibit 2. The equality of β_a and β_c to β_u and constant business risk also ensure that these betas remain constant. Third, the expressions of the rates k and k_o are consistent with the rates k_a and k_c, provided debt is priced at par so that $r = k_d$.

At time t=0, we know the debt ratio L but the market and book values of debt are unknown prior to estimating the firm's value; hence, the interest tax shields are not known. Therefore, the value of the firm can be estimated by applying expressions (2B.1) or (2B.2) in Exhibit 2, which are based on the free cash flow approach. The APV method and the capital (or total) cash flows approach can be used only after the debt ratio is known.

Debt Priced at Par

To enact this debt policy, the firm must first estimate its value in each period and then issue debt with a book value that is at par with the market value of debt implied by the ratio L. This is possible when the coupon rate r is set equal to the market discount rate k_d. With $B_{t-1} = D_{t-1} = LV_{t-1}$, the end-of-period t tax shields are TrB_{t-1} or Tk_dD_{t-1}. The valuation expression (2B.1) requires that estimates of k_d and k_u are available at $t = 0$. The unlevered cost of capital, k_u, can be estimated by means of the CAPM as $k_u = r_f + \beta_u EP$ (where EP is the equity premium, $k_m - r_f$). The value of unlevered beta, β_u, can be obtained depending on the case at hand. For a publicly traded firm, the unlevered beta is estimated from the firm's levered beta by means of expression (2A.8) or (2A.9) in Exhibit 2. For investments with different business risk than the firm's average risk and for privately held firms, we can follow the pure-play approach and use the unlevered beta of firms with similar business risk. To apply the textbook overall cost of capital, k_o, approach, as in expression (2B.2), in addition to k_d, we need the cost of equity k_e. The latter is estimated by the MM expression (2A.5) in Exhibit 2 or by the CAPM using the β_e expressions (2A.8) or (2A.9) of Exhibit 2.[5]

[5] When debt is risky but beta is assumed to be zero, the CAPM and the MM expressions do not yield identical values for k_a, k_c, and k_o. This point is often missed when, as usual, the cost of debt is assumed to be the riskless rate. Using the CAPM, we can express the MM equation (for proportional debt) $k_e = k_u + (k_u - k_d)D/E$ as $k_e = r_f + \beta_u EP + (r_f + \beta_u EP - r_f - \beta_d EP)D/E$. With further simplifications, this yields $k_e = r_f + (\beta_u(V/E) - \beta_d(D/E))EP$. Recognizing that $\beta_e = \beta_u(V/E) - \beta_d(D/E)$, we finally obtain $k_e = r_f + \beta_e EP$. This proves that the MM and CAPM expressions produce identical values for k_e only if we use the correct beta value. This can be generalized to the case of fixed debt.

Numerical Example

The numerical example that follows assumes a five-year period during which the firm is expected to generate uneven end-of-period unlevered after-tax free cash flows that range from $1,000,000 in period 1 to $11,800,000 in period 5.The period 5 terminal cash flow includes the liquidation value of equity. The primary input data are shown in Panel A of Exhibit 3. To allow a more general context, debt is assumed to be risky and determined according to the CAPM with a non-zero beta equal to .20.[6] The debt is fully payable in period 5 at its end-of-period 4 outstanding book value. The values of the composite rates k, k_o, k_a, k_c, and k_e, estimated from the expressions reported in Exhibit 2, appear in Panel B of Exhibit 3. Due to the assumption of constant business risk and debt ratio the expected values of these rates are constant in all five periods. As expected, all CAPM-based estimates of the discount rates k, k_o, k_a, k_c, and k_e are consistent with those estimated according to the MM expressions (2A.1) to (2A.5) in Exhibit 2, and the composite rates k_a and k_c are equal to k_u.

Exhibit 3. Finite Cash Flows and Proportional Debt Priced at Par.

Panel A: Input Data[1]	
r_f	0.05
$EP = k_m - r_f$	0.06
β_u	1
$k_u = r_f + \beta_u EP$	0.11
β_d	0.2
$k_d = r_f + \beta_d EP$	0.062
$r = k_d$	0.062
$k_{ITS} = k_u$	0.11
$L = D/V$	0.25
T	0.35
Panel B: Estimation of Betas and Discount Rates[2]	
$k = k_u - Tk_d(D/V) = k_o$	0.1046
$k_o = k_e(E/V) + k_d(1\text{-}T)(D/V) = k_c - Tk_d(D/V) = k$	0.1046
$k_a = r_f + \beta_a EP$	0.11
$k_a = k_u (V_u/V) + k_u(V_{ITS}/V) = k_c = k_u$	0.11
$k_c = r_f + \beta_c EP$	0.11
$k_c = k_e(E/V) + k_d(D/V) = k_a = k_u$	0.11
$k_e = r_f + \beta_e EP$	0.126
$k_e = k_u + (k_u\text{-}k_d)D/E$	0.126
$\beta_a = \beta_u(V_u/V) + \beta_u(V_{ITS}/V) = \beta_u$	1
$\beta_c = \beta_e(E/V) + \beta_d(D/V) = \beta_a = \beta_u$	1
$\beta_e = \beta_u(V/E) - \beta_d(D/E)$	1.267

(1) All values in Panel A are assumed constant in all periods.
(2) All betas and discount rates are constant in all periods because k_u and L are assumed constant.

[6] Cornell and Green (1991) have estimated the beta of corporate debt to range between 0 and 0.3.

Since the firm's value at any time point is not known in advance, neither the level of debt nor the year-end interest tax shield is known in advance. Therefore, we use the unlevered free cash flow C and the discount rate k or its equal k_o to estimate firm values at each time point. The results are presented in Panel A of Exhibit 4.

Of particular interest are the lines Debt, Debt Adjustment and Equity. The firm's debt in each period from t = 0 to t = 4 is set as LV_t. Since this amount varies over time, the firm is expected to rebalance its debt as shown in the line Debt Adjustment. Based on the year-on-year differences of the value of debt, the firm is shown to issue additional debt in period 1 and withdraw debt in the remaining 4 periods. The new debt at t = 1 is expected to be issued at par at a coupon rate of 6.2%, the time t = 0 expected market interest rate. The debt adjustment path the firm will have to follow in the periods t = 1 to t = 4 is anticipated at time t = 0.Each period the value of equity is $(1\text{-}L)V_t$. It can be shown that it is also equal to the present value of the free cash flow to equity(CFE) discounted at k_e back to each period t (see expression (2B.6)).

Once we have estimated the value of debt in each period, we can then estimate the interest tax shields and the total cash flows. Panels B and C of Exhibit 3 show, respectively, that the total and capital cash flow approaches as well as the APV method yield values consistent with those of Panel A based on the free cash flows discounted at k and k_o.

Debt Not Priced at Par

When debt is not issued at par to its market value, k_dD is not equal to the interest charge in each period, i.e., rB. Hence, it is not possible to derive the expressions (2A.1) and (2A2) of Exhibit 2 for k and k_o. An approximate WACC estimate is possible (given the rates k_e and k_d and the firm's target debt ratio) but it will not be consistent with the values of k_a and k_c the more the coupon rate and book value of debt deviate from the market rate and market value of debt, respectively. This implies that expression (2B.2) which utilizes the composite rate k_o can yield only an approximate estimate of value. Although the composite rates k_a and k_c can be estimated at time t = 0 given the known constant debt ratio L, the expressions (2B.3) to (2B.5) do not yield correct value estimates because the interest tax shields cannot be correctly estimated in the absence of accurate estimates of the value of the firm and its debt. For the same reason the APV method yields approximate value estimates as well.

The above observations suggest that, when cash flows have a finite life and debt is set as a ratio of firm value and is not priced at par, estimates of the firm's value and its debt are possible only as approximations of their true values. Therefore, under a proportional debt policy, debt priced at par is a necessary condition for consistent valuation according to the cost of capital and the APV approaches.

Exhibit 4. Estimation of Values. Finite Cash Flows and Proportional Debt Priced at Par

Panel A: The Free Cash Flow Approach (k or k_o)						
	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**	**t = 5**
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
V at each period	11,178,905	11,347,939	11,334,650	11,119,971	10,682,842	
D = B at each period[1] = .25V	2,794,726	2,836,985	2,833,662	2,779,993	2,670,711	
Debt Adjustment[2]		42,259	-3,322	-53,670	-109,282	-2,670,711
E at each period as V-D	8,384,179	8,510,954	8,500,987	8,339,978	8,012,131	
CFE		929,631	1,082,347	1,232,134	1,378,684	9,021,660
E at each period as PV of CFE stream[3]	8,384,179	8,510,954	8,500,987	8,339,978	8,012,131	
Panel B: The Total or Capital Cash Flow Approach (k_a or k_c)						
	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**	**t = 5**
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
ITS = TrB_{t-1} = Tk_dD_{t-1}		60,646	61,563	61,490	60,326	57,954
TCF = C + ITS		1,060,646	1,261,563	1,461,490	1,660,326	11,857,954
V at each period	11,178,905	11,347,939	11,334,650	11,119,971	10,682,842	
Panel C: The APV Approach						
	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**	**t = 5**
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
Vu at each period	10,955,211	11,160,284	11,187,915	11,018,586	10,630,631	
ITS		60,646	61,563	61,490	60,326	57,954
V_{ITS} at each period	223,694	187,655	146,734	101,385	52,211	
V at each period = Vu + V_{ITS}	11,178,905	11,347,939	11,334,650	11,119,971	10,682,842	

[1] Each period the market value of debt equals its book value because debt is issued at par.

[2] Outstanding debt in period t minus outstanding debt in period t-1; debt outstanding at t = 4 is fully repaid in period 5.

[3] Each period, E is equal to the present value of the sum of the free cash flow to equity (CFE) plus the value of equity at t + 1 discounted at k_e. CFE is C-R(1-T) plus the net change in debt (i.e., new debt minus repayment), where C is the unlevered free cash flow and R is the interest charge. The terminal cash flow to equity is C-R(1-T) − B_4, where B_4=$D_4$is the maturity value of debt at t = 5.

FINITE CASH FLOWS AND FIXED DEBT

At time t=0, the firm issues a fixed amount of debt with a book value B_0 and a market value D_0. Without rebalancing, the book value of debt remains constant but its market value will vary with k_d. Business risk is determined by the risk structure

of assets at t=0 and is assumed to remain constant, independent of t; thus, k_u is also constant through time. When debt is fixed, the appropriate discount rate of the interest tax shields is the cost of debt, k_d.

A finite life of cash flows and fixed debt raise an interesting question about the estimation of the cost of debt. The book and market value-based debt ratios vary with time and are not known at time t = 0. Unless variation of these ratios does not materially affect the firm's market interest rates, setting the cost of debt at time t = 0 and assuming that it remains constant is problematic. Shivdasani and Zenner (2005) show that credit ratings and in turn the cost of debt are affected more by firm size than leverage ratios. With this caveat in mind, we can assume k_d can be estimated at t = 0 and remains fairly stable. It is possible to derive expressions for the composite rates k_a, k_c, and k_o and their betas but only after we have estimated firm values by the APV method (see Appendix B). The expressions for the cost of capital and beta are reported in Exhibit 5.

Exhibit 5. Expressions for Finite Cash Flows and Fixed Debt.

Panel A: Expressions for Discount Rates and Betas

k *No available expression*

$$k_{o,t} = k_{c,t} - Tk_{d,t}\frac{D_t}{V_t}$$

$$= k_{e,t}\frac{E_t}{V_t} + k_d(1-T)\frac{D_t}{V_t}\ ;\ when\ r = k_d \qquad (5A.1)$$

$$k_{a,t} = \frac{V_{u,t}}{V_t}k_u + \frac{V_{ITS,t}}{V_t}k_{d,t} = k_{c,t} \qquad (5A.2)$$

$$k_{c,t} = k_{e,t}\frac{E_t}{V_t} + k_{d,t}\frac{D_t}{V_t} = k_{a,t} \qquad (5A.3)$$

$$k_{e,t} = k_u\frac{V_{u,t}}{E_t} + k_d\frac{V_{ITS,t} - D_t}{E_t} \qquad (5A.4)$$

$$\beta_{a,t} = \beta_u\frac{V_{u,t}}{V_t} = \beta_{e,t}\frac{E_t}{V_t} = \beta_{c,t};\ when\ \beta_d = 0 \qquad (5A.5)$$

$$\beta_{a,t} = \beta_u\frac{V_{u,t}}{V_t} + \beta_d\frac{V_{ITS,t}}{V_t} = \beta_{c,t};\ when\ \beta_d \neq 0 \qquad (5A.6)$$

$$\beta_{c,t} = \beta_{e,t}\frac{E_t}{V_t} + \beta_d\frac{D_t}{V_t} = \beta_{a,t};\ when\ \beta_d \neq 0 \qquad (5A.7)$$

$$\beta_{e,t} = \beta_u\frac{V_{u,t}}{E_t};\ when\ \beta_d = 0 \qquad (5A.8)$$

$$\beta_{e,t} = \beta_u\frac{V_{u,t}}{E_t} + \beta_d\frac{V_{ITS,t} - D_t}{E_t} = \beta_{a,t}\frac{V_t}{E_t} = \beta_d\frac{D_t}{E_t};\ when\ \beta_d \neq 0 \qquad (5A.9)$$

Panel B: Value Expressions

$$V_0 = \sum_{t=1}^{n}\frac{C_t}{(1+k_u)^t} + \sum_{t=1}^{n}\frac{TrB_0}{(1+k_d)^t} \qquad (5B.1)$$

$$V_0 = \sum_{t=1}^{n}\frac{C_t + TrB_0}{\prod_{i=1}^{t}(1+k_{a,i})} \qquad (5B.2)$$

$$V_0 = \sum_{t=1}^{n}\frac{C_t + TrB_0}{\prod_{i=1}^{t}(1+k_{c,i})} \qquad (5B.3)$$

$$V_0 = \sum_{t=1}^{n}\frac{C_t}{\prod_{i=1}^{t}(1+k_{0,i})} \qquad (5B.4)$$

$$E_0 = \sum_{t=1}^{n}\frac{CFE_t}{\prod_{i=1}^{t}(1+k_{e,i})} \qquad (5B.5)$$

Exhbit 5 shows that with finite cash flows and fixed debt an expression of k in terms of k_u and k_d is not available (see Appendix B). Further, it is not possible to derive the familiar MM expressions for k_e in terms of k_u and k_d. Instead k_e is given by expression (5A.4). The rates k_a and k_c are identical but are not equal to the

unlevered discount rate k_u since the latter is not equal to k_{ITS}. Exhibit 5 shows that the ratios $V_{u,t}/V_t$ and $V_{ITS,t}/V_t$ as well as those of E_t/V_t and D_t/V_t vary over time; thus, k_a, k_c and k_e are time-dependent. The expression for the textbook cost of capital k_o is consistent with k_c provided debt is priced at par. Since the discount rates and betas that appear in Exhibit 5 are estimated only after firm value has been estimated at each time point t, these rates can not be used directly in valuation problems. Assuming that the market rate of debt is expected to remain constant in all periods, the firm's value is estimated by the APV expression (5B.1) in Exhibit 5.[7]

Debt is Priced at Par

The firm issues a fixed amount of debt with a maturity of n periods at a coupon rate r equal to the market rate k_d so that $B_0 = D_0$. This condition allows us to derive an expression for k_o which is consistent with the composite rate k_c. Even so, the rates k_o and k_c are not known prior to estimating the firm's value; hence, neither the free cash flow nor the capital cash flow method can be used. The firm value is computed by applying the APV expression (5B.1) in Exhibit 5,which requires that k_u is available. This poses a computational problem because the beta expressions (5A.8) and (5A.9) in Exhibit 5, used to derive k_u, include ratios that utilize estimates of values for $V_{u,t}$ and E_t neither of which is known at t=0. In this case, we use the pure-play approach to estimate β_u, and then use it to estimate the firm's unlevered rate k_u. Since the unlevered beta, β_u, is independent of whether debt is fixed or a ratio of firm value, one can also use the beta expressions (2A.8) or (2A.9) in Exhibit 2 to extract the value of β_u from pure-play firms that follow a proportional debt policy.[8]

Numerical Example

Panel A of Exhibit 6 reports the same input data that appear in Panel A of Exhibit 3. The exception is that debt is set at $t = 0$ as a fixed amount equal to \$2,794,726 payable in period 5.The cost of debt, k_d, equal to 6.2%, is assumed to be constant in all five periods. The parity of r to k_d ensures we can obtain a valid expression for the composite rate k_o (reported in Panel C).

Panel B presents the value-based ratios used to estimate cost of capital specifications and betas, which are reported in Panel C. These values are computed

[7] If the cost of debt is expected to vary with t, expression (5B.1) must be adjusted to allow for multiple k_d values.

[8] To handle the valuation of finite cash flows when debt is fixed, Ruback (2002) discounts the total cash flow $C_t + ITS_t$ at the unlevered rate k_u estimated by the CAPM as $r_f + \beta_u EP$. This is correct only if we accept that the unlevered cost of capital k_u is the appropriate rate to discount the interest tax shields when debt is a fixed amount.

by the APV method as shown in Exhibit 7. Given the cross-time variability of firm value and its components, the discount rates and betas of Panel C also vary with time. With k_d properly estimated according to its beta, the values of k_a, k_c, and k_e obtain identical values irrespective of the expression used.

Exhibit 6. Finite Cash Flows and Fixed Debt Priced at Par.

Panel A: Input Data [1]					
r_f	0.05				
$EP = k_m - r_f$	0.06				
β_u	1				
$k_u = r_f + \beta_u EP$	0.11				
β_d	0.2				
$k_{ITS} = k_d = r_f + \beta_d EP$	0.062				
$r = k_d$	0.062				
B_0 [2]	2,794,726				
T	0.35				
Panel B: Estimation of Value and Debt Ratios (beginning of period)					
	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**
$V_{u,t}/V_t$	0.9773	0.9816	0.9858	0.9900	0.9947
$V_{u,t}/E_t$	1.3019	1.3015	1.3078	1.3220	1.3468
$V_{ITS,t}/V_t$	0.0227	0.0184	0.0142	0.0099	0.0053
$V_{ITS,t}/E_t$	0.0302	0.0244	0.0189	0.0133	0.0072
D_t/V_t	0.2493	0.2458	0.2462	0.2511	0.2615
E_t/V_t	0.7507	0.7542	0.7538	0.7489	0.7385
D_t/E_t	0.3321	0.3259	0.3267	0.3353	0.3541
Panel C: Estimation of Betas and Discount Rates (beginning of period) [3]					
	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**
k No expression available					
$k_{o,t} = k_{e,t}(E_t/V_t) + k_d(1-T)(D_t/V_t)$	0.1035	0.1037	0.1039	0.1040	0.1040
$k_{a,t} = r_f + \beta_{a,t}\ EP$	0.1089	0.1091	0.1093	0.1095	0.1097
$k_{a,t} = k_u\ (V_{u,t}/V_t) + k_d(V_{ITS,t}/V_t) = k_{c,t}$	0.1089	0.1091	0.1093	0.1095	0.1097
$k_{c,t} = r_f + \beta_{c,t}EP$	0.1089	0.1091	0.1093	0.1095	0.1097
$k_{e,t} = k_{e,t}(E_t/V_t) + k_d(D_t/V_t) = k_{a,t}$	0.1089	0.1091	0.1093	0.1095	0.1097
$k_{e,t} = r_f + \beta_{e,t}EP$	0.1245	0.1245	0.1248	0.1255	0.1266
$k_{e,t} = k_u(V_{u,t}/E_t) + k_d((V_{ITS,t}/E_t) - (D_t/E_t))$	0.1245	0.1245	0.1248	0.1255	0.1266
$\beta_{a,t} = \beta_u\ (V_{u,t}/V_t) + \beta_d(V_{ITS,t}/V_t) = \beta_{c,t}$	0.9819	0.9853	0.9886	0.9920	0.9957

Exhibit 6. (*Continued*).

Panel C: Estimation of Betas and Discount Rates (beginning of period) [3]

	t = 0	t = 1	t = 2	t = 3	t = 4
$\beta_{e,t} = \beta_{e,t}(E_t/V_t) + \beta_d(D_t/V_t) = \beta_{a,t}$	0.9818	0.9852	0.9886	0.9920	0.9957
$\beta_{e,t} = \beta_u(V_{u,t}/E_t) + \beta_d((V_{ITS,t}/E_t)–(D_t/E_t))$	1.2415	1.2412	1.2462	1.2576	1.2775

[1] All values in Panel A are assumed constant in all periods.

[2] Book value of debt is the same as in the case of proportional debt and remains constant.

[3] Betas and discount rates (except k_u and k_d) vary because value and debt ratios vary across time (see Panel B).

Exhibit 7 presents the value calculations. Panel A reports values estimated by the APV and CFE methods using, respectively, expression (5B.1) and (5B.5). With debt priced at par and fixed, its market value is equal to its book value in all periods. That is, discounting the maturity value and the remaining interest payments back to any time point t yields the constant book value of $2,794,726. The value of equity at each t is the difference of firm value minus the market value of debt. It is also equal to the present value of the equity cash flows (CFE) discounted at the time-varying $k_{e,t}$ using expression (5B.5).

Exhibit 7. Value Calculations. Finite Cash Flows and Fixed Debt Priced at Par.

Panel A: The APV and CFE Approach

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
Vu at each period	10,955,211	11,160,284	11,187,916	11,018,586	10,630,631	
B_0	2,794,726	2,794,726	2,794,726	2,794,726	2,794,726	
R= K_dB		173,273	173,273	173,273	173,273	173,273
ITS = Interest tax shields		60,646	60,646	60,646	60,646	60,646
V_{ITS} at each period	254,077	209,184	161,508	110,876	57,105	
V at each period = V_u + V_{ITS}	11,209,288	11,369,469	11,349,424	11,129,462	10,687,736	
D at each period[1] = B	2,794,726	2,794,726	2,794,726	2,794,726	2,794,726	
E at each period as V_t-D_t	8,414,562	8,574,743	8,554,698	8,334,736	7,893,010	
CFE		887,373	1,087,373	1,287,373	1,487,373	8,892,647
E at each period as PV of CFE stream[2]	8,414,599	8,574,784	8,554743	8,334,788	7,893,068	

Exhibit 7. (*Continued*).

Panel B: The Total or Capital Cash Flow Approach ($k_{a,t}$ or $k_{c,t}$)

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
ITS = TrB_{t-1} = $TkdD_{t-1}$		60,646	60,646	60,646	60,646	60,646
TCF = C + ITS		1,060,646	1,260,646	1,460,646	1,660,646	11,860,646
V at each period[3]	11,209,288	11,369,469	11,349,424	11,129,462	10,687,736	

Panel C: The Free Cash Flow Approach ($k_{o,t}$)

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
V at each period[3,4]	11,209,288	11,369,469	11,349,424	11,129,462	10,687,736	

[1] Each period, D equals the present value of the sum of period t + 1 market value of debt plus the interest charge discounted at kd, where value of debt at t = 5 equals its book value at t = 0.

[2] Each period t, E is equal to the present value of the sum of the free cash flow to equity (CFE) plus the value of equity at t + 1 discounted at $k_{e,t}$. CFE is C-R(1-T), where C is the unlevered free cash flow and R is the interest charge.

With debt fixed at t = 0, there is no change in book value of debt. The terminal value of equity at t = 5 is C-R(1-T)-B_0., where B is the maturity value of debt. Small deviations from the equity values estimated as V_t-D_t are due to rounding.

[3] Cash flows are discounted at multiple time-varying rates.

[4] The rate k_o can be applied only if k_d equals the constant r (debt priced at par) in all periods.

Panels B and C of Exhibit 7 present values calculated according to the total capital cash flow and free cash flow methods, respectively. The respective streams of cash flows are discounted at the time-varying (i.e., multiple) discount rates $k_{c,t}$ (or its equal $k_{a,t}$) and $k_{o,t}$. Both yield firm value estimates which are consistent with those obtained by the APV method. In both cases, the cash flows to equity (not shown) are identical to those reported in Panel A for the APV method. Discounted at the multiple rates $k_{e,t}$ reported in Panel C of Exhibit 6 they yield identical equity market values (not reported).

Debt Not Priced at Par

The firm issues a fixed amount of debt with a maturity of n years, a book value B_0, and a coupon rate r different from the market rate k_d. Hence, B_0 is not equal to the market value of debt, D_t, in the periods t = 0 to n. In this case, we cannot derive an expression of k_o that is consistent with k_c. Assuming the k_d is known and constant, the firm's value is estimated by the APV method using expression (5B.1).

Numerical Example

The input data appear in Panel A of Exhibit 8 and, with the exception of r, are the same as those reported in Panel A of Exhibit 6. At time t = 0, the firm issues $2,794,726 of debt with a coupon interest rate of 5% and a market rate of 6.2% expected to remain constant for the duration of the loan. Panel B presents various value-based ratios, where the values have been calculated by applying the APV method as reported in Exhibit 9. We use the ratios to estimate the expressions of the cost of capital and beta, which are reported in Panel C of Exhibit 8. As shown, the discount rates and betas vary with time due to the cross-time variability of the value-based ratios. Since r and k_d differ, estimates of the textbook cost of capital, k_o, consistent with k_c are not available.

Exhibit 8. Finite Cash Flows and Fixed Debt Not Priced at Par.

Panel A: Input Data [1]	
r_f	0.05
$EP = k_m - r_f$	0.06
β_u	1
$k_u = r_f + \beta_u EP$	0.11
β_d	0.2
$K_d = r_f + \beta_d EP = k_{ITS}$	0.062
r	0.05
B_0 [2]	$2,794,726
T	0.35

Panel B: Estimation of Value and Debt Ratios (beginning of period)

	t = 0	**t = 1**	**t = 2**	**t = 3**	**t = 4**	**t = 5**
$V_{u,t}/V_t$	0.9816	0.9851	0.9885	0.9919	0.9957	
$V_{u,t}/E_t$	1.2879	1.2902	1.2990	1.3157	1.3433	
$V_{ITS,t}/V_t$	0.0184	0.0149	0.0115	0.0081	0.0043	
$V_{ITS,t}/E_t$	0.0241	0.0195	0.0151	0.0107	0.0058	
D_t/V_t	0.2378	0.2365	0.2390	0.2461	0.2588	
E_t/V_t	0.7622	0.7635	0.7610	0.7539	0.7412	
D_t/E_t	0.3120	0.3097	0.3141	0.3264	0.3492	
V_t/E_t	1.3120	1.3097	1.3141	1.3264	1.3492	

Exhibit 8. (*Continued*).

Panel C: Estimation of Discount Rates (beginning of period)[3]

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
k No expression available						
$k_{o,t}$ No expression consistent with k_c						
$k_{a,t} = r_f + \beta_{a,t}EP$	0.1091	0.1093	0.1094	0.1096	0.1098	
$k_{a,t} = k_u(V_{u,t}/V_t) + k_d(V_{ITS,t}/V_t) = k_{c,t}$	0.1091	0.1093	0.1094	0.1096	0.1098	
$k_{c,t} = r_f + \beta_{c,t}EP$	0.1091	0.1093	0.1094	0.1096	0.1098	
$k_{c,t} = k_{e,t}(E_t/V_t) + k_d(D_t/V_t) = k_{a,t}$	0.1091	0.1093	0.1094	0.1096	0.1098	
$k_{e,t} = r_f + \beta_{e,t}EP$	0.1238	0.1239	0.1243	0.1252	0.1265	
$k_{e,t} = k_u(V_{u,t}/E_t) + k_d((V_{ITS,t}/E_t) - (D_t/E_t))$	0.1238	0.1239	0.1243	0.1252	0.1265	
$\beta_{a,t} = \beta_u(V_{u,t}/V_t) + \beta_d(V_{ITS,t}/V_t) = \beta_{c,t}$	0.9853	0.9881	0.9908	0.9936	0.9965	
$\beta_{c,t} = \beta_{e,t}(E_t/V_t) + \beta_d(D_t/V_t) = \beta_{a,t}$	0.9853	0.9881	0.9908	0.9936	0.9965	
$\beta_e = \beta_u(V_{u,t}/E_t) + \beta_d((V_{ITS,t}/E_t)–(D_t/E_t))$	1.2304	1.2322	1.2392	1.2526		1.2747

[1] All values in Panel A are constant through time.

[2] The book value of debt is the same as in the case of proportional debt and remains constant over time.

[3] Betas and discount rates (except ku and kd) vary because value and debt ratios vary across time (see Panel B).

When debt is a fixed amount, only the APV method can be used directly to estimate the firm's value. The values are reported in Panel A of Exhibit 9 and are estimated according to expression (5B.1). Since debt is not priced at par, its market value, D, varies with t and differs from the book value of debt, B_0. The value of equity at each period t is the difference of the value of the firm, V_t, minus the market value of debt, D_t. It is also equal to the present value of the free cash flows to equity (CFE) discounted at the time-varying rate k_e.

Panel B of Exhibit 9 shows the value calculations when the total (capital) cash flow $C_t + ITS_t$ is discounted at the composite rate k_c or its equal k_a. In all t periods, we obtain firm values identical to those produced by the APV approach. In this case, unlike the case of proportional debt not priced at par, correct estimation by the APV method is possible because the rates k_u and k_d as well as the tax shields can be reliably estimated at time t = 0. Thus, with correct estimates of the market-

Exhibit 9. Value Calculations. Finite Cash Flows and Fixed Debt Not Priced at Par.

Panel A: The APV and CFE Approach

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
V_u at each period t	10,955,211	11,160,284	11,187,915	11,018,586	10,630,631	
B_0	2,794,726	2,794,726	2,794,726	2,794,726	2,794,726	
$R = k_dB_0$		139,736	139,736	139,736	139,736	139,736
$ITS = TrB_{t-1}$		48,908	48,908	48,908	48,908	48,908
V_{ITS} at each period	204,901	168,697	130,249	89,416	46,052	
V at each period = $V_u + V_{ITS}$	11,160,112	11,328,981	11,318,164	11,108,002	10,676,683	
D at each period[1]	2,654,222	2,679,048	2,705,413	2,733,412	2,763,147	
E at each period as $V_t - D_t$	8,505,889	8,649,933	8,612,751	8,374,591	7,913,536	
CFE at each period		909,171	1,109,171	1,309,171	1,509171	8,914,445
E at each period as PV of CFE stream[2]	8,505,889	8,649,933	8,612,751	8,374,591	7,913,536	

Panel B: The Total or Capital Cash Flow Approach ($k_{a,t}$ or $k_{c,t}$)

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
C		1,000,000	1,200,000	1,400,000	1,600,000	11,800,000
$ITS = Tk_dB_0$		48,908	48,908	48,908	48,908	48,908
TCF = C + ITS		1,048,908	1,248,907	1,448,907	1,648,907	11,848,907
V at period t[3]	11,160,110	11,328,979	11,318,162	11,108,001	10,676,682	

[1] Each period, D equals the present value of the sum of the interest charge plus the market value of debt at t + 1 discounted at k_d. The maturity value of debt at t = 5 is the book value of debt at t = 0.
[2] Each period, E is equal to the present value of the sum of the free cash flow to equity (CFE) plus the value of equity at t + 1discounted at $k_{e,t}$. CFE is C-R(1-T), where C is the unlevered free cash flow and R is the interest charge.
[3] With debt fixed at t = 0, there are no changes in debt. The terminal value of equity at t = 5 is C-R(1-T)-B_0, where B is the maturity value of debt.

value debt ratios, discounting total (capital) cash flows at k_a and k_c yields value estimates consistent with the APV method.

SUMMARY AND CONCLUSIONS

The paper covers the valuation of finite cash flows under proportional and fixed debt when the latter is not necessarily priced at par value. The purpose is two-fold: (a) to show under what conditions the alternative valuation techniques can be used to yield correct and consistent results; and (b) to provide numerical

examples that demonstrate the application of valuation approaches in the case of finite cash flows.

When debt is set proportional to firm value and is priced at par, the textbook WACC approach yields correct valuation results that are consistent with other valuation techniques. When debt is not priced at par, the alternative valuation approaches can only yield approximation solutions. When debt is a fixed amount, the APV method yields valid estimates of value, consistent with those produced by the capital and free cash flow approaches. This holds whether debt is valued at par or not.

Since the textbook cost of capital can be used to estimate consistent values only in the case of proportional debt, the additional requirement that debt is priced at par value severely limits its applicability as a valuation tool. This poses a critical challenge to the most typical approach to valuation found in corporate finance textbooks. In particular, the possibility that firms do not adhere strictly to a policy of maintaining a constant debt-to-value ratio makes it critical that students learn valuation methods other than discounting cash flows at the WACC.

Notwithstanding the extant evidence in support of proportional debt policy (Frank and Goyal, 2009), there is considerable evidence in favor of the fixed debt policy (Fernandez, 2007; and Shyam-Sunder and Myers,1999). Firms also seem to deviate from long-run target debt ratios in periods during which they are active in mergers and acquisitions (Harford, Klasa, and Walcott, 2009). During such periods firms operate with a fixed schedule of debt. This is also the case when firms undergo restructuring in private equity deals (Ruback, 2002). Therefore, valuation under a policy of fixed debt (not necessarily valued at par) covers a larger number of valuation cases than the reliance on the textbook cost of capital implies. This dictates that instruction on valuation should allow for greater coverage of the APV method, which is directly applicable when debt has a fixed schedule and whether debt is priced at par or not. The exercises in this paper would help accomplish the goal of identifying situations in which discounting cash flows at the WACC is appropriate and situations when valuation should follow the APV approach. Greater exposure to a wider set of valuation cases will ensure that finance graduates are better prepared to engage in valuation as financial managers.

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APPENDIX A: Derivation of Cost of Capital and Beta Expressions for Finite Cash Flows and Proportional Debt

Cost of Capital Expressions

When debt is set proportional to firm value, both the unlevered cash flows and the interest tax shields are discounted at k_u. Therefore, the rates k_a and k_u are equal and we can write:

$V_t = \frac{C_{t+1} + TrB_t}{1 + k_u} = \frac{C_{t+1} + V_{t+1}}{1 + k_u} + \frac{TRB_t}{1 + k_u}$. Rearranging the terms of the second equality, we get $V_t(1 - \frac{TrB_t / V_t}{1 + k_u}) = \frac{C_{t+1} + V_{t+1}}{1 + k_u}$. Solving for V_t, we obtain $V_t = \frac{C_{t+1} + V_{t+1}}{1 + k_u - TrB_t / V_t}$, where the denominator is equal to 1+k. This yields $k = k_u - TrB_t/V_t$. Unless debt is priced at par, B_t cannot be estimated before V_t and D_t are known. To estimate k independent of V, it is necessary to assume that debt is valued at par and thus B_t equals D_t or LV_t. Also assuming a constant k_d we obtain:

$$k = k_u - Tk_dL = k_u(1 - \frac{Tk_dL}{k_u}). \qquad \text{(A.1)}$$

Expression (A.1) is equivalent to the expression of k for the perpetuity case and it is the Modigliani-Miller version of the cost of capital with finite-life cash flows and proportional debt. The discount rates k and k_a can be used to estimate the value of the firm as in expressions (2B.1) and (2B.3) of Exhibit 2. With k_{ITS} equal to k_u, the APV is estimated by expression (2B.5) in Exhibit 2.

To derive the relationship between k, k_c and k_o, we write the value of the firm at time t as:

$V_t = (C_{t+1} + V_{t+1})/(1+k)$. Adding and subtracting $rB_t(1\text{-}T)$ in the numerator of the right-hand side, and since $V_{t+1} = E_{t+1} + D_{t+1}$, we get $V_t = [(C_{t+1} - rB_t(1\text{-}T) + E_{t+1}) + (D_{t+1} + rB_t) - TrB_t]/(1+k)$. The quantity in the first parenthesis is the required payoff to the time t equity, i.e., $(1+k_e)E_t$. The quantity in the second parenthesis is the required payoff to the time t debt, i.e., $(1+k_d)D_t$. Recognizing that the debt ratio is assumed to be independent of time, dividing both sides by V_t, rearranging, and simplifying yields:

$$k = k_e(1 - L) + k_dL - Tr\frac{B_t}{V_t} = k_c - Tr\frac{B_t}{V_t}$$

To reduce this expression to the textbook weighted average cost of capital formulation, we must assume $r=k_d$, which implies debt is valued at par, and $B_t = D_t = LV_t$. This yields:

$$k = k_u - Tk_dL = k_c - Tk_dL = k_o. \qquad \text{(A.2)}$$

The discount rates k_o and k_c are used to estimate the firm's value as in expressions (2B.2) and (2B.4) in Exhibit 2.

Beta Expressions

The value of the firm at t is:

$V_t = \frac{C_{t+1} + V_{t+1}}{(1 + k_u)} + \frac{TrB_t}{(1 + k_u)}$. The asset portfolio beta, β_a, is the weighted average of the unlevered beta, β_u, and the beta of the interest tax shields, β_{ITS}, and equals the constant β_u. Hence:

$$\beta_{a,t} = \beta_u \frac{(C_{t+1} + V_{t+1}) /(1 + k_u)}{V_t} + \beta_u \frac{TrB_t /(1 + k_u)}{V_t} = \beta_u.$$

The beta of the portfolio of capital claims, $\beta_{c,t}$, at time t is given by $\beta_{e,t}(E_t/V_t) + \beta_d(D_t/V_t)$, where the debt ratio, equal to L, is constant for all t. Setting $\beta_a = \beta_c$, and solving for β_e, we obtain

$\beta_e = \beta_u(1/(1\text{-}L)) - \beta_d(L/(1\text{-}L))$. When β_d is equal to zero, $\beta_e = \beta_u(1/(1\text{-}L))$.

APPENDIX B: Deriving Cost of Capital and Beta Expressions for Finite Cash Flows and Fixed Debt

Cost of Capital Expressions

When debt is a fixed amount independent of value and cash flows have a finite life, it is not possible to derive the discount rate k in terms of k_u and k_{ITS}.[9] This is so because the value of the firm's assets at time t is:

$$V_t = \frac{C_{t+1}}{(1+k_u)} + \frac{TrB_0}{(1+k_d)} + \frac{V_{t+1}}{(1+k_{a,t})}$$

Unlike the case of proportional debt, the components of V_{t+1}, i.e., $V_{u,t+1}$ and $V_{ITS,t+1}$ can not be discounted at k_u. The correct discount rate for V_{t+1}, is instead k_a, which varies with t since the value components V_u and V_{ITS} are time-dependent. Assuming constant cost of debt, the firm value at t=0 is estimated as in expressions (5B.1) and (5B.2) in Exhibit 5.

To derive the expressions of k_c and k_o that are consistent with k_a, we write: $V_t = \frac{C_{t+1} + V_{t+1} + TrB_0}{1+k_{a,t}}$, where $k_{a,t} = k_u(V_{u,t}/V_t) + k_d(TD_t/V_t)$. Adding and subtracting $rB_0(1\text{-}T)$ in the numerator of the right-hand side and rearranging yields: $V_t - TrB_0/(1+k_{a,t}) = [(C_{t+1}\text{-}rB_0(1\text{-}T) + E_{t+1}) + (D_{t+1}+rB_0) - TrB_0]/(1+k_{a,t})$. The quantity $C_{t+1} - rB_0(1\text{-}T) + E_{t+1}$ is the payoff to the time t equity, i.e., $(1+k_{e,t})E_t$, whereas the quantity $D_{t+1} + rB_0$ is the payoff to the time t debt, i.e., $(1+k_{d,t})D_t$. After dividing by V_t and simplifying, we obtain:

$$k_{a,t} - Tr\,\frac{B_0}{V_t} - k_{e,t}\,\frac{E_t}{V_t} + k_{d,t}\,\frac{D_t}{V_t} - Tr\,\frac{B_0}{V_t} + k_{c,t} - Tr\,\frac{B_0}{V_t}. \qquad \text{(B.1)}$$

Assuming that debt is valued at par and k_d is constant, so that $D_t = B_0$ and $rB_0 = k_dD_t$ in all periods, we can derive the expression for the textbook cost of capital:

$$k_{a,t} - Tk_d\frac{D_t}{V_t} - k_{c,t} - Tk_d\frac{D_t}{V_t} = k_{o,t} = k_{e,t}\frac{E_t}{V_t} + k_d(1-T)\frac{D_t}{V_t} \qquad \text{(B.2)}$$

where $D_t/V_t = B_0/V_t$.

In expressions (B.1) and (B.2), the rates k_c and k_o vary with t because the debt ratios are allowed to vary in each period. These expressions are mere definitions of k_c and k_o and as such they cannot be estimated before the firm's value has been estimated in all periods and the ratios D_{t-1}/V_{t-1} are available.

Provided the composite rates k_c and k_o have been estimated, the value of capital claims is given by expressions (5B.3) and (5B.4) in Exhibit 5.

[9] An expression of k as a function of k_u and k_d can be derived only in the case of a one-period cash flow (Myers, 1974).

Beta Expressions

Setting the asset portfolio beta equal to the capital claims beta yields: $\beta_{e,t} = \beta_u \frac{V_{u,t}}{V_t} + \beta_d \frac{V_{ITS,t}}{V_t} = \beta_{c,t} = \beta_{e,t} \frac{E_t}{V_t} + \beta_d \frac{D_t}{V_t}$. Solving for $\beta_{e,t}$ yields:
$\beta_{e,t} = \beta_u \frac{V_{u,t}}{E_t} + \frac{V_{ITS,t} - D_t}{E_t} = \beta_{a,t} \frac{V_t}{E_t} - \beta_d \frac{D_t}{E_t}$.
Assuming $\beta_d = 0$, following the same approach we obtain: $\beta_{e,t} = \beta_u \frac{V_{u,t}}{E_t}$.

There is More to Cash Flow than the Statement of Cash Flow

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There are generally two competing definitions of cash flow that differ by the amount of the tax break provided by interest expense. Although these measures of cash flow appear to be different, a direct connection between the two measures emerges when both are put in a valuation context. The connection between the two cash flow measures is readily demonstrable numerically.

INTRODUCTION

"Cash flow" in finance texts is generally defined in one of two ways: free cash flow (FCF) or cash flow from assets (CFA). FCF (for example, see Brealey. Myers, and Marcus (2012)) is defined as:

FCF = Earnings before interest and taxes (EBIT) × (1 − Tax rate) + Depreciation expense − Δ Net working capital − Δ Fixed assets (1)

CFA (for example, see Brooks (2013)) is defined as:

CFA = Earnings after taxes (EAT) + Depreciation expense + Interest expense − Δ Net working capital − Δ Fixed assets (2)

Note: an equivalent definition of CFA is provided by Ross, Westerfield, and Jordan (RWJ) (2013):

CFA = Earnings before interest and taxes (EBIT) +Depreciation expense − Taxes − Δ Net working capital − Δ Fixed assets (3)

The definition of CFA in equation (2) will be used throughout the article.

Although both definitions of cash flow can be used as a means of determining the value of a project or a firm, the two calculations are not necessarily equivalent

if leverage is present. Subtracting FCF from CFA reveals the difference between the two calculations as the value of the tax shield provided by interest.

$$\text{CFA} - \text{FCF} = \text{Interest expense} \times \text{Tax rate} \tag{4}$$

This leads to a potential conundrum as to which definition of cash flow is correct or better.

In a recent paper by Petty and Rose (2009), the paper authors urge textbook authors to provide more of a connection between the "cash flow identity" and the accounting statement of cash flow. Using RWJ's definitions for the cash flow to creditors (CFC) and the cash flow to shareholders (CFS):

$$\text{CFC} = \text{Interest Expense} - \Delta\,\text{Long-term debt} \tag{5}$$

$$\text{CFS} = \text{Dividends} - \Delta\,\text{Stock} \tag{6}$$

The "cash flow identity" becomes:

$$\text{CFA} - \text{CFC} - \text{CFS} = 0 \tag{7}$$

Expand Equation (7) and solve for the change in cash (Δ Cash):

$$\text{CFA} - \text{CFC} - \text{CFS} = \text{EAT} + \text{Depreciation expense} + \text{Interest expense} - [\Delta\,\text{Cash} + \Delta\,\text{Accounts receivable} + \Delta\,\text{Inventory} - \Delta\,\text{Current liabilities}] - \Delta\,\text{Fixed assets} - [\text{Interest Expense} - \Delta\,\text{Long-term debt}] - [\text{Dividends} - \Delta\,\text{Stock}] = 0 \tag{8}$$

$$\Delta\,\text{Cash} = \text{EAT} + \text{Depreciation expense} - \Delta\,\text{Accounts receivable} - \Delta\,\text{Inventory} + \Delta\,\text{Current liabilities} - \Delta\,\text{Fixed assets} - \text{Interest Expense} + \Delta\,\text{Long-term debt} - \text{Dividends} + \Delta\,\text{Stock} \tag{9}$$

Equation (9) is in a form that is consistent with the accounting statement of cash flow (Note: a number of simplifying assumptions have been made for clarity purposes: no marketable securities or cash equivalents, no use of accruals, all interest bearing debt is considered long-term debt, no deferred taxes, and no leases…such items can be incorporated if desired). From this perspective, CFA appears to be the better definition of cash flow because of its consistency with the accounting statement of cash flow or CFA is at least more internally consistent with financial statements in general.

However, such a conclusion should not be made so quickly because FCF is a very pervasive definition of cash flow (advanced corporate texts that use FCF include Damodaran (1994) and more recently, Koller, Goedhart, and Wessels (2010)). Further, as Ruback (2002) demonstrates, the two definitions of cash flow can actually be connected to each other when considering project or firm valuation.

The purpose of this paper is to demonstrate this "valuation" connection between CFA and FCF using a simple example. The further pedagogical benefit is to demonstrate how the two different cash flow definitions are also linked to

two different, but related discount rate assumptions. The connectivity between cash flow and the discount rate is not apparent in textbook treatments because textbooks generally use FCF or CFA and not both cash flow definitions. By using both definitions of cash flow, the connectivity between cash flow and discount rate is readily demonstrated.

The next section demonstrates mathematical proofs of the equivalence of FCF and CFA valuation methods. In section two, a numerical presentation of the results from section one is performed. In section three, a common valuation mistake is demonstrated that gives the appearance that CFA and FCF lead to different valuations. Section four concludes the paper.

THE VALUATION CONNECTION BETWEEN CFA AND FCF

Following Ruback (2002) and Arnold and Nixon (2011), FCF and CFA require different discount rates because FCF and CFA differ by the tax break generated from interest payments on debt (see equation(4) in the previous section). One way of interpreting FCF is that it is the non-levered equivalent of CFA. Although this is not a "perfect" interpretation, it does capture the idea that CFA should be discounted at a rate higher than the discount rate for FCF because CFA incorporates the tax benefit of being levered.

Assume that FCF is to be discounted by the weighted average cost of capital (WACC). Let debt (D) have a cost of k_D and equity (E) have a cost of k_E, where the value of the firm (V) equals (D + E).

$$\text{WACC} = k_D \times (1 - \text{Tax rate}) \times (D/V) + k_E \times (E/V) \tag{10}$$

Re-arranging the calculation:

$$\text{WACC} = \{k_D \times (D/V) + k_E \times (E/V)\} - k_D \times \text{Tax rate} \times (D/V)$$
$$\text{WACC} = \text{PWACC} - k_D \times \text{Tax rate} \times (D/V) \tag{11}$$

"PWACC" is defined as the pre-tax weighted average cost of capital.

Following Ruback (2002), assume a project has perpetual cash flows. The valuation of these cash flows based on FCF becomes:

$$\text{Value (V)} = \text{FCF} \div \text{WACC} \tag{12}$$

The corresponding valuation using CFA is:

$$\text{Value (V)} = \text{CFA} \div \text{PWACC} \tag{13}$$

Notice, both valuations incorporate the benefit of leverage. When using FCF, the tax break associated with debt is within the calculations of the WACC. When using CFA, the tax break associated with debt is within the calculation of the CFA. The question becomes: Do both methods generate the same value? Fortunately, the answer is: yes.

PROOF (start with equation (12)):

$$V = FCF \div WACC$$
$$V \times WACC = FCF$$
$$V \times \{PWACC - k_D \times \text{Tax rate} \times (D/V)\} = FCF$$
$$V \times PWACC - k_D \times \text{Tax rate} \times D = FCF$$
$$V \times PWACC = FCF + k_D \times \text{Tax rate} \times D$$
$$V \times PWACC = CFA$$
$$V = CFA \div PWACC \quad (14)$$

If there is only a single cash flow one year from today, a similar proof generates the same result.

$$V = FCF \div (1 + WACC)$$
$$V \times (1 + WACC) = FCF$$
$$V \times (1 + PWACC - k_D \times \text{Tax rate} \times (D/V)) = FCF$$
$$V \times (1 + PWACC) - k_D \times \text{Tax rate} \times D = FCF$$
$$V \times (1 + PWACC) = FCF + k_D \times \text{Tax rate} \times D = FCF + \text{Interest rate} \times \text{Tax rate}$$
$$V \times (1 + PWACC) = CFA$$
$$V = CFA \div (1 + PWACC) \quad (15)$$

Consequently, it is within a valuation context that FCF and CFA become connected. It is not a question of whether debt should be excluded from a valuation, but rather a question of where debt should be incorporated within the valuation (i.e. within the cash flow or within the discount rate). In the next section, this will be demonstrated numerically.

A NUMERICAL EXAMPLE OF THE VALUATION OF THE CONNECTION BETWEEN CFA AND FCF

Let CFA be $1,000.00 that is paid out annually into perpetuity with a tax rate of 40% and equity and debt both equal $5,000.00 (implying V = $10,000.00). If the cost of debt and equity respectively are 6% and 14%, the PWACC is 10%.

$$PWACC = 6\% \times (\$5{,}000.00 / \$10{,}000.00) + 14\% \times (\$5{,}000.00 / \$10{,}000.00)$$
$$PWACC = 10\% \quad (16)$$

Based on the CFA, V = $10,000.00, which is also consistent with the value based on the debt and equity.

$$V = \$1{,}000.00 \div 10\% = \$10{,}000.00 \quad (17)$$

Compare this to a similar valuation using the FCF. The perpetual FCF is $880.00 based on subtracting out the tax benefit of debt from the CFA.

$$FCF = \$1{,}000.00 - 6\% \times \$5{,}000.00 \times 40\% = \$880.00 \quad (18)$$

The WACC becomes 8.8% based on the PWACC of 10% or using a direct computation.

$$WACC = PWACC - 6\% \times (\$5{,}000.00 / \$10{,}000.00) \times 40\% = 8.8\% \quad (18)$$

$$WACC = 6\% \times (1 - 40\%) \times (\$5{,}000.00/\$10{,}000.00) + 14\% \times (\$5{,}000.00 / \$10{,}000.00) = 8.8\% \quad (19)$$

Based on the FCF, V still equals $10,000.00:

$$V = \$880.00 \div 8.8\% = \$10{,}000.00 \quad (20)$$

Again, if the value is based on a single cash flow one year into the future, CFA and FCF will produce similar valuations. Some adjustments are necessary to the calculations in order to keep WACC and PWACC at 8.8% and 10% respectively. V is set at $909.09 (i.e. $1,000.00 ÷ [1+ 10%] = CFA ÷ [1 +PWACC]) with D and E both set at $454.545 (i.e. 50% of value).

$$WACC = 6\% \times (1 - 40\%) \times (\$454.45/\$909.09) + 14\% \times (\$454.545 / \$909.09) = 8.8\% \quad (21)$$

$$PWACC = 6\% \times (\$454.545 / \$909.09) + 14\% \times (\$454.545 / \$909.09)$$
$$PWACC = 10\% \quad (22)$$

The valuation is again the same whether using FCF with WACC or CFA with PWACC:

$$V = CFA \div (1 + PWACC) = \$1{,}000.00 \div (1 + 10\%) = \$909.09 \quad (23)$$

$$FCF = \$1{,}000.00 - 6\% \times \$454.545 \times 40\% = \$989.09 \quad (24)$$

$$V = FCF \div (1 + WACC) = \$989.09 \div (1 + 8.8\%) = \$909.09 \quad (25)$$

Numerically and by proof in the previous section, the valuation connection between CFA and FCF is solidly demonstrated when there is one cash flow or perpetual cash flows. What about when there is more than one annual cash flow, but the number of cash flows is finite?

The equivalence between the two methods will still be true, but numerically, the process is iterative. In other words, by maintaining WACC and PWACC at 10% and 8.8% respectively, an implicit assumption is made that the debt and equity levels will change to maintain the initial proportionate levels of debt and equity relative to value (V). For convenience, keep the annual CFA payout constant at $1,000.00 and then see the effect on how FCF must change in order to keep WACC (and PWACC) constant.

This can be demonstrated for two years of annual CFA cash flow of $1,000.00. First, set the value (V) based on the cash flows:

$$V = \$1{,}000.00 \div (1+ 10\%)^1 + \$1{,}000.00 \div (1 + 10\%)^2 = \$1{,}735.54 \quad (26)$$

In order to maintain the annual WACC at 8.8% and PWACC at 10%, the debt (D) and the equity (E) are set at $867.77 (i.e. 50% of value).

$$WACC = 6\% \times (1 - 40\%) \times (\$867.77/\$1{,}735.54) + 14\% \times (\$867.77 / \$1{,}735.54) = 8.8\% \quad (27)$$

$$PWACC = 6\% \times (\$867.77 / \$1{,}735.54) + 14\% \times (\$867.77 / \$1{,}735.54)$$
$$PWACC = 10\% \quad (28)$$

The first FCF (FCF_1) is $979.17 based on the CFA of $1,000.00:

$$FCF_1 = \$1{,}000.00 - 6\% \times \$867.77 \times 40\% = \$979.17 \quad (29)$$

The iterative portion of the exercise now enters because the value of the cash flows one year from today (V_1) has to be calculated in order to determine the amount of debt (D_1) and equity (E_1) that are necessary to maintain the WACC and PWACC at 8.8% and 10% respectively one year from today (denoted with time subscripts). Once debt and equity have been set, the second FCF (FCF_2) value can be determined.

$$V_1 = \$1{,}000.00 \div (1 + 10\%) = \$909.09 \quad (30)$$

(Note: after one year, there is only one more CFA remaining to be received in the future)

$$D_1 = E_1 = 50\% \times \$909.09 = \$454.545 \quad (31)$$

$$WACC_1 = 6\% \times (1 - 40\%) \times (\$454.45/\$909.09) + 14\% \times (\$454.545 / \$909.09) = 8.8\% \quad (32)$$

$$PWACC_1 = 6\% \times (\$454.545 / \$909.09) + 14\% \times (\$454.545 / \$909.09)$$
$$PWACC_1 = 10\% \quad (33)$$

The second FCF (FCF_2) is $989.09:

$$FCF_2 = \$1{,}000.00 - 6\% \times \$454.545 \times 40\% = \$989.09 \quad (34)$$

Notice, FCF_2 is greater than FCF_1 because the debt level lowered making the tax benefit of debt smaller (bringing the CFA and FCF closer in value).

Based on the FCF, the valuation of the cash flows is still $1,735.54 (Note: there can be rounding error of approximately $0.01):

$$V = \$979.17 \div (1+ 8.8\%)^1 + \$989.09 \div (1 + 8.8\%)^2 = \$1{,}735.54 \quad (35)$$

The dynamic nature of FCF (and CFA if it had been allowed to vary) can be captured in this iterative fashion or within a pro forma analysis. However, the main point demonstrated in this section is that the combination of CFA with PWACC and the combination of FCF with WACC should still yield the same valuation for a series of cash flows. Without seeing this valuation connection between CFA and FCF, it is difficult to rectify why there are two different means of calculating cash flows. Ruback's (2002) treatment is much more thorough than what is presented here, but the intuition comes through very clearly with this numerical example.

The issue one has to be aware of when performing a valuation is that if WACC and PWACC are going to be constant then there is an implicit assumption that the debt and equity portions of the project adjust to the residual value of the project through time. The following section discusses this further and demonstrates a very common mistake.

IMPLICT ADJUSTMENT OF DEBT (AND EQUITY) THROUGH TIME

It is common practice to set WACC (and PWACC) as a constant throughout the life of a project. However, this creates an implicit assumption that debt and equity adjust through time with the residual value of the project. For example, if a project has a five year life-span (for simplicity, assume no initial costs) and produces $1,000.00 annual cash flows, using a discount rate of 10%, the project has an initial value of $3,790.79. If the project is funded with equal amounts of debt and equity, the debt level and equity level are set to: $1,895.395 (i.e. = $3,790.79 ÷ 2).

Next year, after the first annual cash flow has been exhausted, the residual value of the project is based on the four remaining years of cash flows and is worth $3,169.87. If the WACC (and PWACC) are to remain constant, the debt level and equity level need to be reduced to $1,584.935. After another year, the debt and equity levels need to be reduced to $1,243.425 as the residual project value (based on the three remaining years of cash flow) declines to $2,486.85. This process continues as the project reaches maturity, the project value declines and the debt and equity levels decrease to maintain the constant values of WACC and PWACC.

No matter which cash flow definition is used, CFA or FCF, using a constant WACC or PWACC throughout the valuation process creates an implicit assumption that debt and equity levels change throughout the life of the project. Because of this implicit assumption, two valuation mistakes are possible: (1) Not adjusting debt and equity levels to maintain a constant WACC or PWACC throughout the project while applying a constant WACC or PWACC within the valuation or (2) not adjusting cash flows to recognize the change in the debt and equity level necessary for maintaining a constant WACC or PWACC.

The solution for the first mistake is to re-compute WACC (and PWACC) through time based on the residual value of the project and the prevailing debt and equity levels at a given moment in time. The solution to the second mistake is to

realize the dynamic nature of CFA and FCF based on the changing debt level as was done in the previous section.

The second mistake tends to manifest itself in a manner that makes CFA and FCF appear different from each other within a project valuation over a finite set of periods greater than one. Going back to the last numerical example in the previous section, V equals $1,734.54, D and E equal $867.77, WACC equals 8.8%, and PWACC equals 10% (following equations (26) through (28)). In equation (29), FCF for the first year is $979.17, but often is mistakenly assumed to be constant or at least less dynamic than it really is.

CFA is assumed to be constant at $1,000.00 annually in this example for simplicity. However, be careful in interpreting the constant CFA of $1,000.00. This assumes the debt and equity levels are changing throughout the project to maintain the constant WACC of 8.8% and PWACC of 10%. The CFA remaining a constant $1,000.00 is the result of another portion of the cash flow (technically, the FCF portion within the CFA) increasing to compensate for the declining tax break over time. The CFA is assumed to be constant, but its component parts are most assuredly not constant.

Because FCF has been incorrectly made constant (set at $979.17) when it should be increasing through time as the debt level and its associated tax break decrease, the valuation based on CFA and FCF appear to be different (see Table 1). Curiously, the difference in value between the correctly executed CFA valuation and the incorrectly executed FCF valuation eventually dissipates when the length of the project becomes sufficiently long.

Table 1. Difference Between a Correct Valuation of Cash Flows and a Common Erroneous Valuation of Cash Flows.

Correct Valuation: CFA = $1,000.00 PWACC = 10%	**Value of FCF_1:**	**Incorrect Valuation: FCF = FCF_1 WACC = 8.8%**	**Difference in Value:**	**Number of Annual Cash Flows (N):**
$909.09	$989.09	$909.09	$0.00	1
$1,735.54	$979.17	$1,727.16	$8.38	2
$3,790.79	$954.51	$3,732.06	$58.73	5
$6,144.57	$926.27	$5,997.14	$147.43	10
$8,513.56	$897.84	$8,314.11	$199.45	20
$9,426.91	$886.88	$9,275.52	$151.39	30
$9,779.05	$882.65	$9,686.45	$92.60	40
$9,914.81	$881.02	$9,864.03	$50.78	50
$9,999.27	$880.01	$9,997.93	$1.34	100
$9,999.99	$880.00	$9,999.97	$0.02	150
$10,000.00	$880.00	$10,000.00	$0.00	200

$FCF_1 = CFA_1 - k_D \times D \times Tax\ rate$

Apply the values from the example: $CFA_1 = \$1{,}000.00$, $k_D = 6\%$, Tax rate $= 40\%$, $D = 50\% \times V$, and $V = (\$1{,}000.00 \div 10\%) \times [1 - 1/(1 + 10\%)^N]$

$$FCF_1 = \$1{,}000.00 - 6\% \times \left[50\% \times \frac{\$1{,}000.00}{10\%}\left(1 - \frac{1}{(1 + 10\%)^N}\right)\right] \times 40\%$$

The amount of difference can be quite substantial if "N" is not particularly large and explaining why the difference exists, i.e. the adjustment of FCFs through time to be consistent with WACC and PWACC being held constant, is not a particularly easy explanation to make. Consequently, the best advice here is to avoid making such an erroneous comparison and explain the proper interaction between CFA and PWACC and between FCF and WACC by using the numerical example in the previous section to demonstrate that the valuations using the two different methods are equivalent.

CONCLUSION

This paper demonstrates that both definitions of cash flow: CFA and FCF are consistent with each other in a valuation context. Because CFA differs from FCF by the value of the tax break from interest on debt, the appropriate form of the weighted average cost of capital for discounting CFA is the PWACC. That is, there should be no consideration for the tax break from debt within the discount rate because the cash flow (CFA) already accounts for the tax break. Vice versa, because there is no tax benefit from debt in the calculation of FCF, the WACC should account for the tax break within the discount rate.

Numerically, the "valuation" equivalence between CFA and FCF are demonstrated with particular attention given to the debt and equity levels of funding throughout the project. Using either measure of cash flow, the use of a constant value for WACC (and PWACC) throughout the valuation process creates an implicit assumption of debt and equity levels changing through time. If CFA and FCF are not adjusted for the changing debt and equity levels through time, an incorrect valuation will emerge and/or valuations based on CFA and FCF will be inconsistent with each other.

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Portfolio Diversification and Investment Risk

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This study enriches current finance pedagogy by providing empirical examples that illustrate the relationship between portfolio diversification and investment risk. In addition to showing that the standard deviation of portfolio returns decreases with the number of stocks in the portfolio as indicated in most finance textbooks, we use the Capital Asset Pricing Model and Fama-French Three-Factor Model to estimate systematic risk and demonstrate that the amount of systematic risk cannot be eliminated by portfolio diversification. We also construct industry portfolios to illustrate the concept that investors can benefit more from portfolio diversification if they select unrelated stocks to construct portfolios. Furthermore, we provide examples that directly demonstrate the systematic risk principle by showing that the industries with higher systematic risk on average have higher average returns.
Keywords: *Portfolio diversification, systematic risk, investment risk, industries, number of securities*

Introduction

Modern portfolio theory can be traced back to Markowitz's (1952, 1959) pioneering works that describe how diversifiable risk can be reduced by increasing the number of securities in the portfolio. Based on Markowitz's works, William Sharpe, John Lintner, and Jan Mossin independently developed the famous Capital Asset Pricing Model (Lintner, 1965 a, b; Mossin, 1966; Sharpe, 1964). At the same time, Markowitz's work is followed by several studies that try to examine the number of securities needed to achieve most of the benefits of portfolio diversification and the rate at which risk is reduced when more securities are included into the portfolio. This issue is important in portfolio management since the benefit of risk reduction from portfolio diversification is usually accompanied by an increase in transaction cost. The first of such studies was conducted by Evans

and Archer (1968). Using the standard deviation of portfolio returns around mean return of that portfolio to measure risks, Evans and Archer (1968) suggested that about 10 securities would be enough to get most of the benefit from diversification. Bird and Tippett (1986), on the contrary, used an exact parametric relationship between portfolio standard deviation and portfolio size and suggested that a larger portfolio size is needed to fully benefit from portfolio diversification. Elton and Gruber (1977) provided an analytical analysis that describes the relationship between the number of securities in a portfolio and portfolio risk. They indicated that while the standard deviation of a portfolio's returns decreases at a lower rate with number of securities added into the portfolio, a portfolio of 15 stocks still has about 32 percent more risk than a portfolio of 100 stocks. Statman (1987) compared the marginal benefit of risk reduction from portfolio diversification with the marginal cost of adding more securities into the portfolio and concluded that a well-diversifiable portfolio needs to have at least 30-40 stocks. This is consistent with Campbell, Lettau, Malkiel, and Xu's (2001) finding that 40-50 stocks are needed for a well-diversified portfolio.

The purpose of this study is to provide examples that illustrate the relationship between portfolio diversification and investment risk. The investment risk can be classified into systematic and unsystematic risk. Systematic risk is related to factors that affect almost all securities in the financial market, such as inflation rate, interest rate, and GDP growth rate. On the other hand, unsystematic risk is asset specific, and at most only affects a few securities in the market. Since unsystematic risk is asset specific, it can be reduced via portfolio diversification. Therefore, unsystematic risk is also called diversifiable risk. On the other hand, systematic risk is called non-diversifiable risk because it affects almost all securities in the market and cannot be eliminated from diversification. Following previous studies, we measure total investment risk with the standard deviation of security returns and show that investors can reduce total investment risk by increasing the number of stocks in the portfolio. However, when investors have about 30 stocks in their portfolio, they can barely reduce risk further by adding more stocks into the portfolio. In addition to showing that the standard deviation of portfolio returns decreases with portfolio size as indicated in most finance textbooks, we use the Capital Asset Pricing Model and Fama-French Three-Factor Model to estimate systematic risk and demonstrate that regardless of portfolio size, the amount of systematic risk remains at similar levels and cannot be eliminated by portfolio diversification. This comparison helps students to understand the differences between systematic and non-systematic risk. Our simulation also suggests that the three-factor model is better specified than the market model in relating portfolio return to systematic risk.

We also construct portfolios with stocks randomly selected from individual industries to examine the rate at which risk is reduced when more securities of the same industry are added into the portfolio. We show that the benefit of risk reduction from portfolio diversification is reduced when stocks are selected from

one particular industry instead of from the entire market. Although the concept that a portfolio is better diversified if it is constructed with unrelated stocks is not new in finance, this study uses industry portfolios as an example to illustrate it. Our study also provides evidence that directly demonstrates the systematic risk principle. According to the systematic risk principle, only systematic risk is rewarded by the market. We compare systematic risk and average returns of different industries and show that on average industries with higher systematic risk have higher average returns. Several finance textbooks illustrate the tradeoff between return and risk by showing that historically assets with higher standard deviations of returns are better rewarded by the market (see, e.g., Berk, Demarzo, & Harford, 2014; Bodie, Kane, & Marcus, 2010; Ross, Westerfield, & Jordan, 2015). For instance, Ross, Westerfield, and Jordan (2015) showed that the average and standard deviation of returns on the portfolio of small company stocks are higher than that of large company stocks, which in turn are higher than that of long-term corporate bonds, long-term government bonds, and Treasury bills. Since standard deviations of returns measure total investment risk that includes both systematic and unsystematic risk, a positive relationship between standard deviations of returns and asset returns does not lead itself to the systematic risk principle. Our study supplements finance pedagogy by providing direct evidence that shows a positive relationship between average asset returns and systematic risk.

Simulation Results

Portfolio Diversification

We consider all stocks listed on NYSE, AMEX, or NASDAQ during the period from December 1925 to December 2014. To ensure we include enough observations, we exclude stocks listed on the markets for less than ten years from our sample. We consider monthly security returns and obtain the security data from CRSP. To construct portfolios of N securities, we randomly select N different stocks and compute equally weighted portfolio returns. We then compute the mean and standard deviation of portfolio returns during the entire sample period. For each N, we perform the simulation 5,000 times and then compute the average of mean and standard deviation of portfolio returns. We use the mean standard deviation of portfolio returns as an estimate of total investment risk for a portfolio containing N stocks.

Figure 1 illustrates the relationship between the number of stocks in the portfolio and the mean standard deviation of monthly portfolio returns. At the beginning, the standard deviation of portfolio returns decreases with the number of stocks in the portfolio. However, after the portfolio contains about 30 stocks,

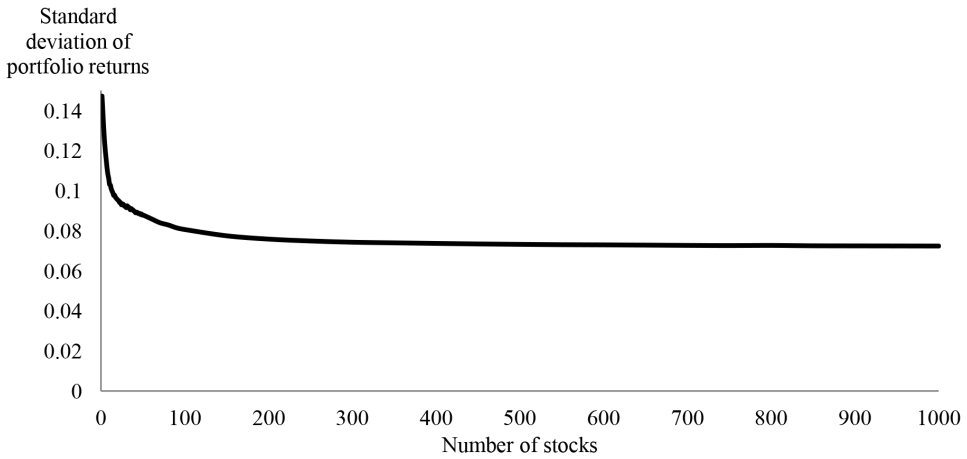


Figure 1. Risk Reduction via Portfolio Diversification.

the impact of portfolio diversification on risk reduction is limited. The part of risk that can be eliminated by portfolio diversification is asset specific and is called diversifiable or unsystematic risk. On the other hand, market risk (or systematic risk) is the type of risk that affects all securities in the market and thus does not decrease with the number of stocks in the portfolio.

Systematic Risk

To decompose total investment risk into systematic and unsystematic risk, we consider the Capital Asset Pricing Model (CAPM) and Fama-French Three-Factor Model, which are specified with the equations below:

CAPM:

$$R_t = R_t^f + \beta(R_t^m - R_t^f) + \varepsilon_t, \text{ and} \quad (1)$$

Fama-French Three-Factor Model:

$$R_t - R_t^f = \beta_1(R_t^m - R_t^f) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_t, \quad (2)$$

where R_t represents portfolio return in month t, R_t^f stands for risk-free rate, and R_t^m represents the return on the market portfolio. SMB and HML denote the size and book-to-market factors, respectively.

To estimate systematic risk, we regress monthly portfolio returns on the risk factors for each simulated portfolio. If the model is well-specified, the residuals are resulted from unsystematic risk and thus the volatility of residuals should be reduced via portfolio diversification. We estimate the standard deviation of residuals for each simulated portfolio and then compute the mean standard deviations of

all portfolios for a given number of N stocks in the portfolio. We use the mean standard deviation of residuals as an estimate of unsystematic risk and estimate systematic risk according to the following formula:

$$\left(\sigma^2_{\text{totalrisk}} - \sigma^2_{\text{unsystmaticrisk}}\right)^{0.5}, \quad (3)$$

where $\sigma^2_{\text{totalrisk}}$ and $\sigma^2_{\text{unsystmaticrisk}}$ represent mean standard deviation of portfolio returns and residuals, respectively.

Figure 2 presents the result of estimated total and systematic risk along with average portfolio returns given different numbers of stocks in the portfolio. Total investment risk is estimated with the mean standard deviation of portfolio returns and systematic risk is estimated with the market and three-factor models, which are represented by Sys_M and Sys_Three, respectively. As Figure 2 illustrates, the average portfolio return is somewhat the same and does not change with the number of stocks in the portfolio. As indicated previously, total portfolio risk can be significantly reduced via diversification when there are a few stocks in the portfolio, but the impact of diversification on risk reduction decreases with the number of securities in the portfolio. For instance, when the number of stocks in the portfolio increases from one to fifty, the mean standard deviation of portfolio returns decreases from 14.7 percent to 8.8 percent, but only to 8.1 percent when there are one hundred stocks in the portfolio. In addition to showing that the standard deviation of portfolio returns decreases with portfolio size as indicated in most finance textbooks, we estimate systematic risk and demonstrate the relationship between systematic risk and portfolio size. As indicated in Figure 2, systematic risk is relatively flat and does not change much with the number of stocks in the portfolio. This agrees with the financial theory that portfolio diversification does not reduce systematic risk. Furthermore, total risk and systematic risk converge as the number of stocks in the portfolio increases. This result helps students to understand that when a portfolio is well diversified, only systematic risk is left in the portfolio. A comparison of the estimated systematic risk between the market and three-factor models suggests that the three-factor model is better specified than the market model in relating portfolio return to systematic risk. For instance, when the portfolio contains 1,000 randomly selected stocks, the estimated systematic risk based on the three-factor model is much closer to total risk, while there is a gap between total risk and the systematic risk estimated with the market model.

To promote student-centered learning, the instructor can ask students the following questions while presenting Figure 2.

- What is the relationship between the amount of total investment risk and the number of securities in the portfolio?
- What is the relationship between the amount of systematic risk and the

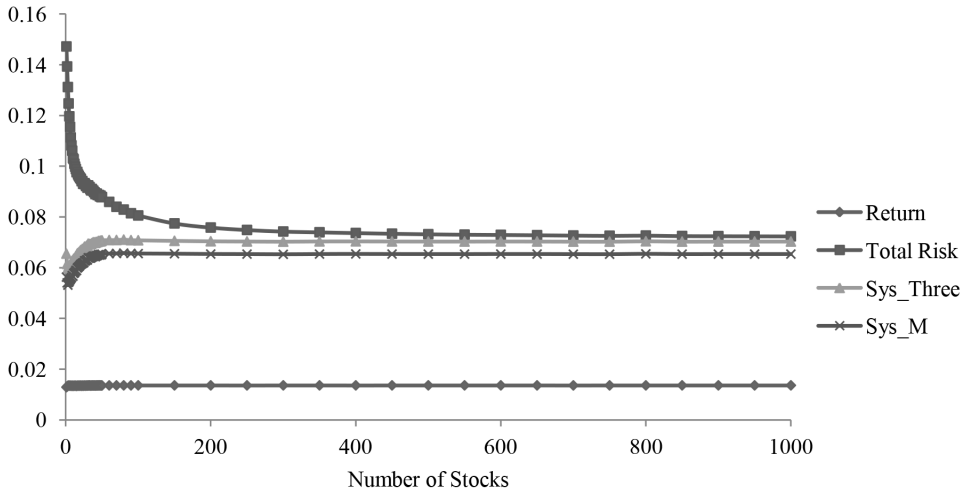


Figure 2. Total Investment Risk and Systematic Risk.

number of securities in the portfolio?

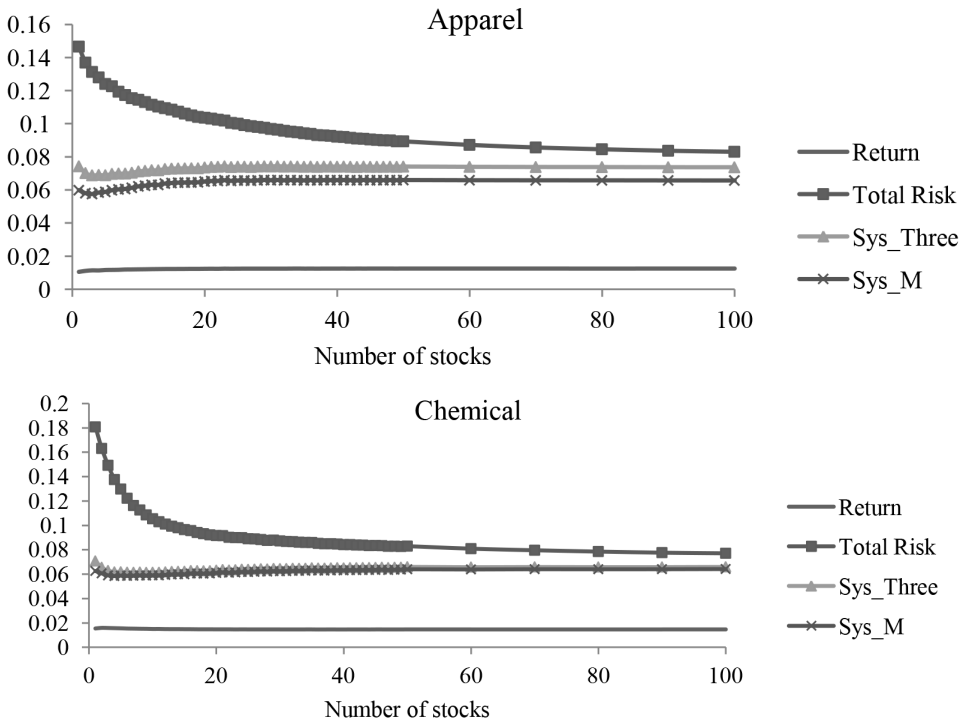
- How would you interpret the gap between total investment risk and systematic risk? How does the gap between total investment risk and systematic risk relate to portfolio size?
- Which model does a better job capturing the systematic risk of securities? Why?
- Can investors increase average portfolio returns by simply adding more securities into the portfolio?

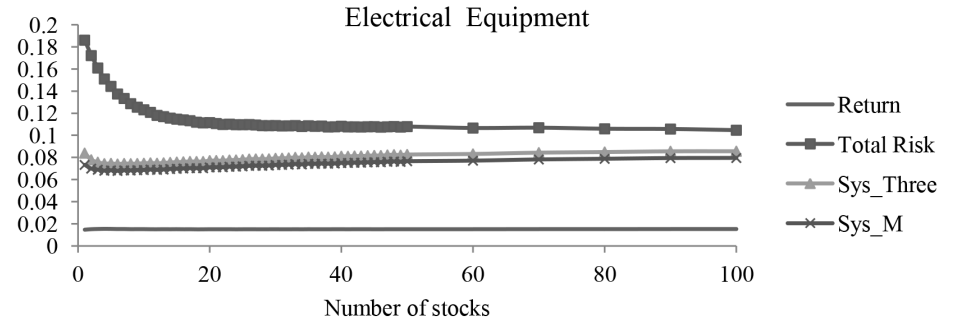
For comparison, we conduct similar simulations but instead of randomly selecting stocks from the market, we randomly select stocks from individual industries. We use two-digit Standard Industrial Classification (SIC) codes to categorize stocks and use groupings similar to those employed by Moskowitz and Grinblatt (1999). Here, we consider Apparel, Chemical, Electrical Equipment, Fabricated Metal, Food, Machinery, Manufacturing, Mining, Other Transport, Retail, and Transport Equipment industries. Here we do not include Financial and Utilities industries due to their skewed financial fundamentals and industries that contain less than two hundred stocks due to their small sample size. Because of smaller sample sizes in individual industries, we only construct industry portfolios with up to one hundred stocks in the simulations. The equally weighted portfolios are constructed with stocks randomly selected from the same industry during the period from December 1925 to December 2014. Figure 3 presents the effect of portfolio diversification on total and systematic risk for individual industries.

The riskiest industries from our analysis are Electrical Equipment, Machinery, and Mining industries, whereas the Food industry is the least risky among all

the industries considered. Industries that carry a higher degree of systematic risk have, on average, higher standard deviations of returns. For each industry, we see total risk decreases with the number of stocks in the portfolio, but the impact of diversification on risk reduction decreases with the number of stocks in the portfolio. Additionally, the effect of risk reduction in an industry portfolio is not as great as that in a portfolio of stocks selected from the entire market. For instance, looking at portfolios containing one hundred randomly selected stocks, the unsystematic risk, which can be approximately measured by the gap between total and systematic risk, is larger in most industry portfolios than that in the portfolio of stocks selected from the market. That is, the effect of adding similar stocks into the portfolio on risk reduction is limited. To assist students in learning these concepts, the instructor may ask students the following questions while presenting Figure 3.

- In terms of total investment risk, which industries are the most risky? Which industries are less risky? What are your answers if you look at systematic risk?
- Can you fully eliminate unsystematic risk by investing in stocks from one particular industry? Why or why not?
- Compare the results from Figures 2 and 3, what do you learn about portfo-




Electrical Equipment
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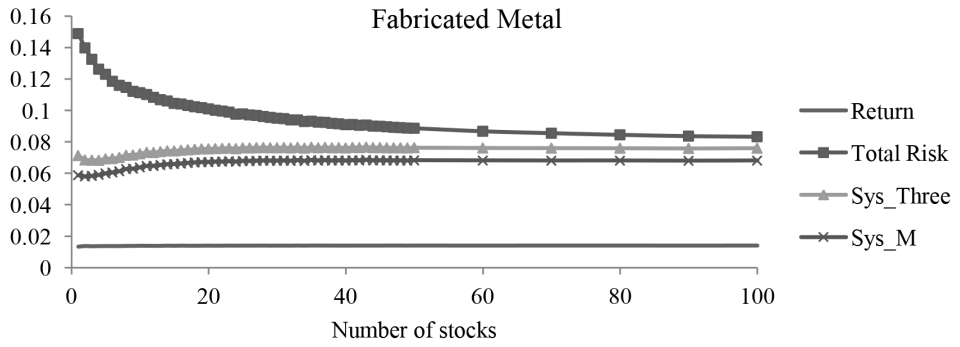
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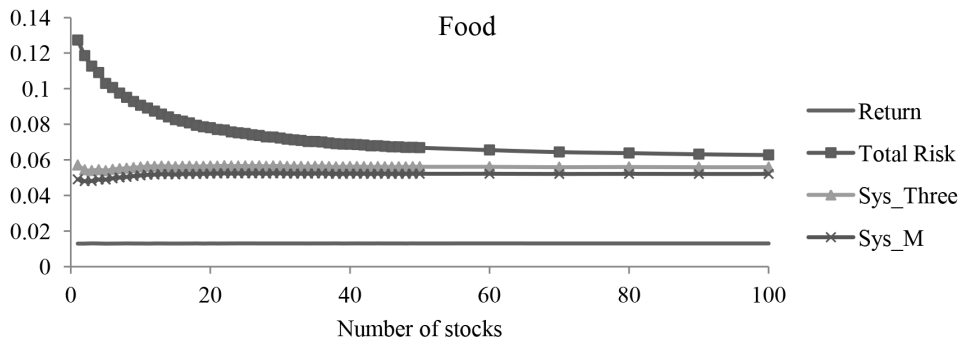
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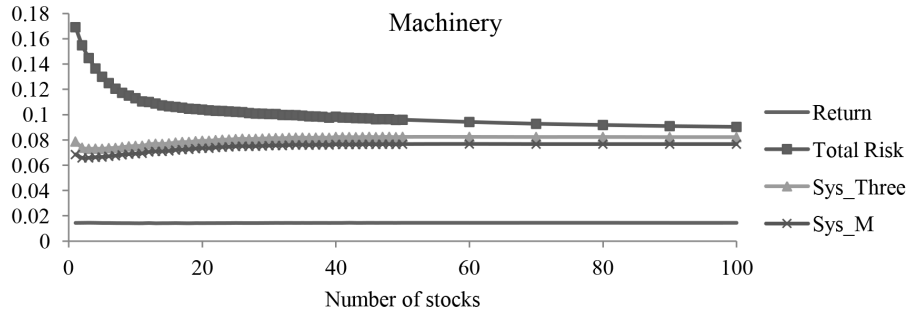
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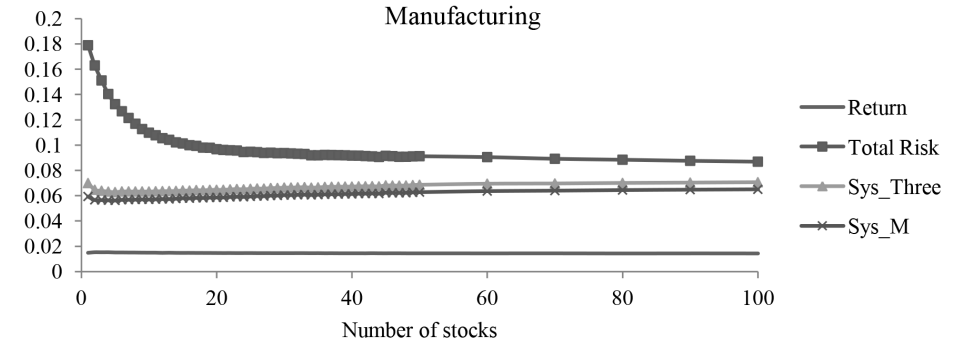
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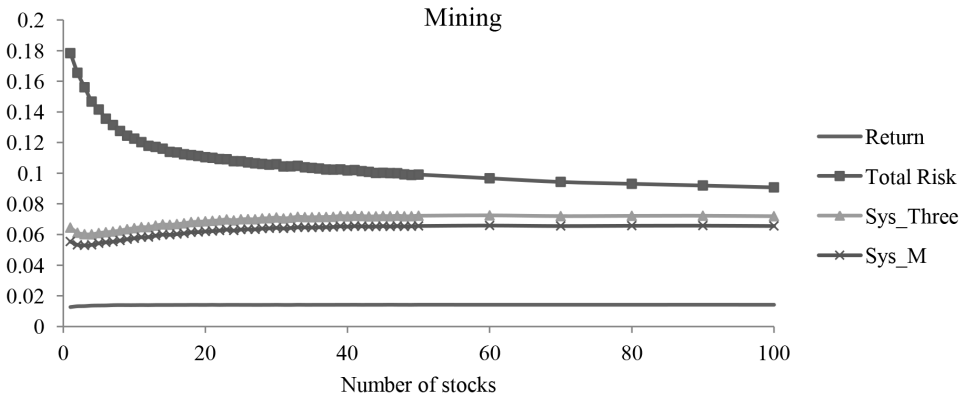
Mining
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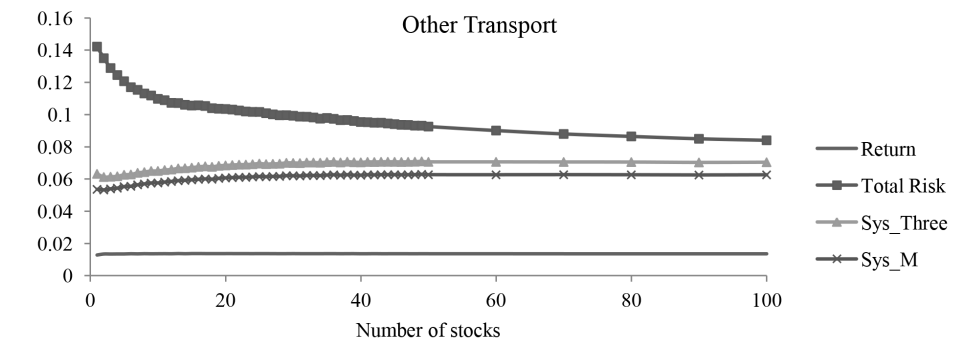
Other Transport
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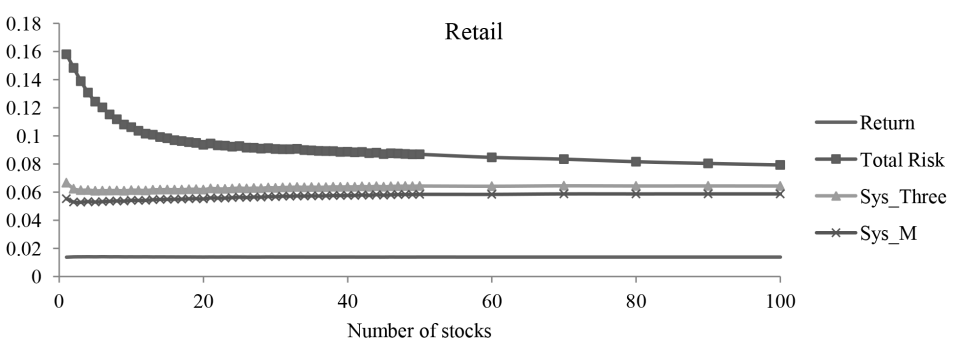
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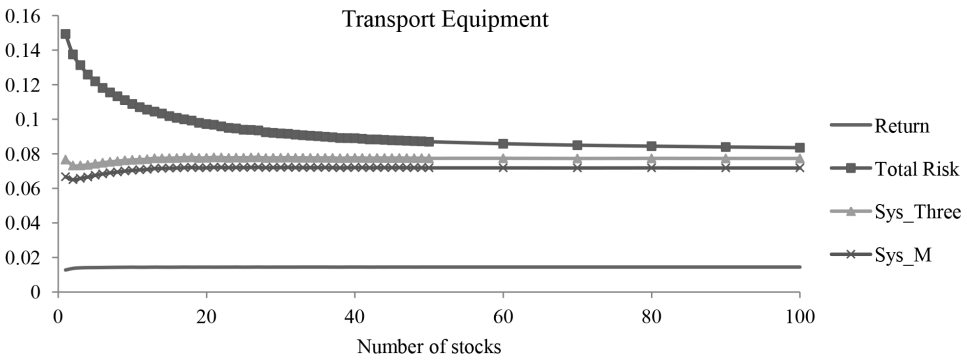


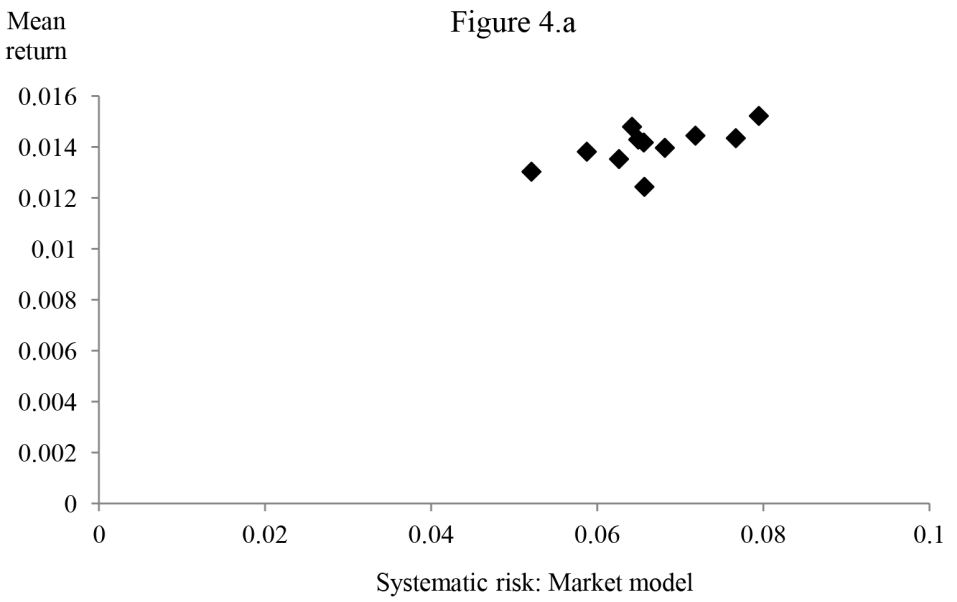
Figure 3. Total Investment Risk and Systematic Risk of Industry Portfolios.

lio diversification?

Systematic Risk and Returns

The capital market history shows that to earn higher returns, investors on average need to bear more risk. Some finance textbooks use the positive relationship between average asset returns and standard deviations of returns to illustrate this important lesson. For instance, Ross, Westerfield, and Jordan (2015) showed that the average and standard deviation of returns on the portfolio of small company stocks are higher than that of large company stocks, which in turn are higher than that of long-term corporate bonds, long-term government bonds, and Treasury bills. Berk, Demarzo, and Harford (2014) indicated a general increasing relationship between historical standard deviations of returns and average returns for Treasury bills, corporate bonds, the S&P 500, the small stock portfolio, and a world portfolio of large company stocks from North America, Europe, and Asia. However, according to systematic risk principle, only systematic risk is rewarded by the market. Since the standard deviations of portfolio returns measure total investment risk, relating mean returns to standard deviations of portfolio returns to illustrate the tradeoff between risk and return is proper only when the portfolio is well diversified and the remaining risk is mostly systematic.

To give examples that directly demonstrate a positive relationship between systematic risk and return, we compare the systematic risk of different industry portfolios with their average returns. Figure 4 illustrates the relationship between systematic risk and mean portfolio returns of different industries, including Apparel, Chemical, Electrical Equipment, Fabricated Metal, Food, Machinery, Manufacturing, Mining, Other Transport, Retail, and Transport Equipment. The systematic risk is estimated with the market and three-factor models and its relationship with the mean returns are presented in Figures 4.a and 4.b, respectively.



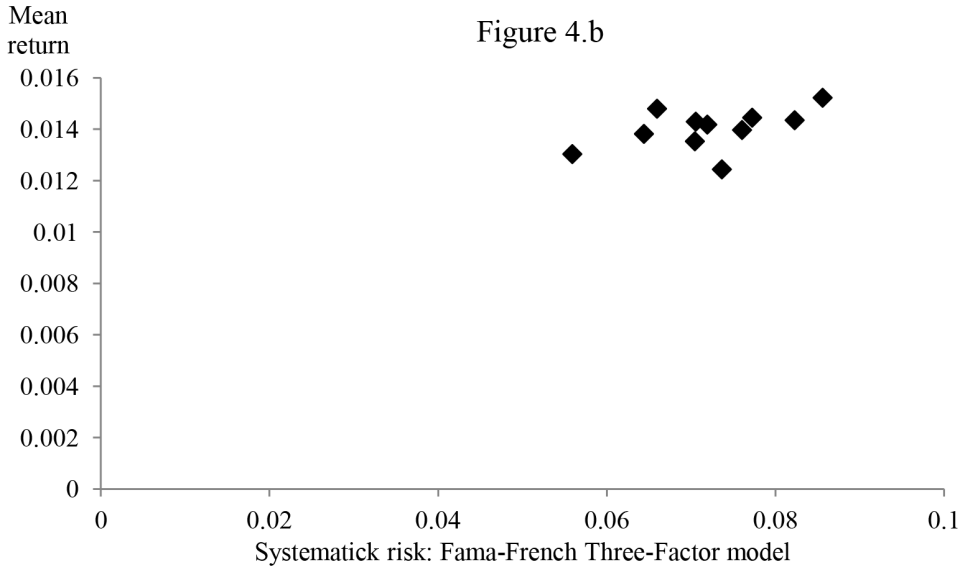


Figure 4. Average Returns and Systematic Risk.

On average, industries with higher amount of systematic risk have a higher average return. Along with the result in Figure 2 that a reduction in unsystematic risk from portfolio diversification does not reduce average portfolio returns, we illustrate the systematic risk principle that only systematic risk is rewarded by

the financial market. To improve student learning, the instructor can help students learn the systematic risk principle by comparing Figures 2 and 4 and identifying the relationship between average return, systematic risk, and unsystematic risk.

Conclusions

We examine the effect of portfolio diversification on the reduction of investment risk by constructing portfolios of stocks from the market and individual industries. We provide examples to help students understand that while unsystematic risk reduces with the number of stocks in the portfolio, systematic risk remains at similar levels. Our simulation suggests that the three-factor model is better specified than the market model in relating portfolio return to systematic risk. We also use industry portfolios as an example to demonstrate that to better diversify away unsystematic risk, investors should select stocks with greater dissimilarity. Finally, we provide examples that directly demonstrate the systematic risk principle by showing that industries with higher systematic risk on average have higher returns. On the other hand, the reduction of unsystematic risk from portfolio diversification does not cause a reduction in portfolio returns. This comparison helps students to learn that only systematic risk is relevant in determining the expected return on a security.

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Using a Live Case to Teach Dual-Class Stocks and Corporate Governance

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In this article, we introduce a case discussion project that utilizes a real-life story to teach important corporate finance subjects such as shareholder rights and dual-class stocks. We start with a background review of the shareholder rights and dual-class shares topics and then introduce our teaching approach that combines of a short live case with lecture and a list of discussion questions that may be used to guide students in applying textbook concepts to analyze real business issues.
Keywords: *live case, dual-class stocks, corporate governance, pedagogy, active shareholders*

INTRODUCTION

Case teaching, long supported by finance faculties, enables students to link theories, conceptual models, and analytical techniques to the actual practice of finance. The benefits of the case method have been described by Roulac (1975), Trahan (1993), and Banning (2003), among others. In this paper, we present a live-case approach to introduce the theory and concepts of shareholder rights and corporate governance to finance students. This case can be used in both introductory and intermediate level corporate finance courses.

Background Review

We start with a review of the topic, shareholder rights and dual-class shares, and then continue with an introduction of our approach in teaching these topics through combining a short live case and lecture. At their discretion, instructors may also use the review content in their lectures as a background introduction for the covered topics.

Shareholders' Voting Rights

As Gompers, Ishii, and Metrics (2003) stated in their seminal paper on corporate governance, "Corporations are republics. The ultimate authority rests with voters (shareholders)" (p. 107). Shareholders' rights and corporate governance are essential topics in introductory and intermediate level corporate finance courses. Every finance student should understand that common stock holders, being investors and owners of a public company, have different rights or responsibilities than do debt holders and preferred stock holders. Among these, the right to vote may be considered the most important. Classic agency theory in financial economics tells us that in corporations, ownership and control are separated. The options through which shareholders can maximize their welfare are in the broad set of corporate governance principles enumerated in the corporation's articles of incorporation and bylaws. The most important legal right shareholders have is the right to vote on important corporate matters, such as elections of boards of directors, mergers and liquidations (Easterbrook & Fischel, 1983), and other issues the board elects to submit for shareholder consideration.

However, shareholders have not been able to use this right much until recently. As summarized by Gillan and Starks (2007), shareholders' options have been limited. It has been much easier to "vote with their feet" and liquidate their shares if they disagree with the company's decisions or become pessimistic about the company's future. Not until 1942 did the Securities and Exchange Commission (SEC) introduce a rule (the predecessor of today's Rule 14a-8) that allowed shareholders to submit proposals for inclusion on corporate ballots. Since then, various groups of shareholders, including both individual and institutional shareholders, have become more and more active in the governance of their corporate holdings, using their voting rights to push for changes in public companies. These active investors are sometimes called "gadfly" investors because they frequently voice their dissatisfaction and submit shareholder proposals, which may or may not sound pleasant to the corporate executives or even the board members. In addition to individuals (retail investors), these investors include, but are not limited to, hedge funds, public pension funds, and private equity funds.

Dual-Class Stocks

Finance students may be surprised to learn that not all common stock holders have equal rights. When founders or early investors want the public equity market to provide financing but do not want to give up their control of the company, they adopt the multiple-class stock structure. This structure allows them to get most of the voting power while only owning a small portion of a company's total stock. These super-voting shares are not usually traded publicly; and company founders and their families are most commonly the controlling groups in dual-

class companies. Brigham and Daves (2013) briefly described this in their widely-adapted corporate finance textbook: "The use of classified stock enabled the public to take a position in a conservatively financed growth company without sacrificing income, while the founder retained absolute control during the crucial early stages of the firm's development", and "the right to vote is often a distinguishing characteristic between different classes of stock" (pp. 166-167).

The dual- or multiple-class structure of common stocks has drawn more and more attention from both academia and investors. Therefore, it's important and practical to introduce this issue to our finance students. Dual-class share structures used to be rare, found primarily in family-run businesses or media companies. Today, several hundred companies in the United States, including high profile companies such as Google, Facebook, and Zynga, have adopted the dual-class structure in their stock ownership design. After Google adopted the dual-class structure for its IPO in 2004, the arrangement became popular among technology companies. However, in its recent stock split in April 2014 in which Class-C shares were sold with no voting rights at all, Google took things to a new level. At Facebook, Mark Zuckerberg controls the Class-B shares, which give him ten times the voting power of the Class-A shares sold to outside shareholders. As a result, his 18% ownership of the company gives him control over more than 50% of the voting power.

Essentially dual-class stocks separate voting rights from cash flow rights. Whether this separation can benefit shareholders has been controversial. Researchers such as Masulis, Wang, and Xie (2009) reported that as the divergence between insider voting rights and cash flow rights widens, CEOs receive higher compensation, managers make shareholder value-destroying acquisitions more often, and capital expenditures contribute less to shareholder value. Gompers, Ishii and Metrick (2010) also reported evidence that firm value is negatively affected by the divergence between insiders' cash flow rights and voting rights.

Nevertheless, (at least some) investors embrace the dual-class share structure. Investors who see great prospect and value in a company have to accept the company's existing dual-class structure and invest in non-voting or inferior-voting stocks. Average shareholders have to trust that super-vote shareholders have better information, judgment, and vision and, therefore, can make better decisions, especially when it comes to long-term strategic plans. If investors get too concerned about the dual-class structure, they may sell their stock, opting out of both the dual-class structure and their investment in the company. Moreover, because monitoring can be costly, many investors, especially small investors, prefer to free ride. That may also be the reason some empirical work (for example, Zingales, 1995) has revealed very low and almost indistinguishable value premiums in stocks with high voting rights in the United States: Investors do not seem to attach too much value to superior voting rights, at least when the control of the firm is not contested through events such as takeover threats.

Live-Case Approach

To help students understand the concepts and practice of shareholder voting rights and dual-class shares better, in this paper, we introduce the use of a live case. We have designed this case to get students involved in the learning of these important corporate governance issues. The case is based on a real company (Ford Motor Company), and instructors can easily collect and update case materials used in class sessions from free online sources. Teaching notes and suggestions have also been provided for instructors interested in using this interactive in-class case discussion approach.

The case material is based on Ford's 2013 proxy statement. In this document, Ford presents a list of proposals brought by various shareholders. Shareholders needed to vote on these proposals at their annual shareholder meeting. The document also includes the board's recommendation for decision on each proposal. The particular proposal in which we are interested focuses on issues tied to Ford's existing dual-class stock structure. Because this is a proposal made by a specific group of shareholders, this case may also serve as a case for classroom discussion on shareholders' rights.

Using short live cases in introductory or intermediate-level finance courses is a way to supplement classroom lectures. The teaching approach we propose here is consistent with the suggestion in Roulac (1975) to create a dynamic learning environment: A case is covered during the same lecture in which the material is covered or during the one immediately following. This interactive live-case approach helps to bring subject matters alive and helps students to understand how shareholder rights are employed in real companies during real events. Trahan (1993) advocated this integration of cases with lectures, suggesting that keeping the case very close to the lecture allows students to apply the "new" theory and see its relevance immediately. Moreover, a short case as suggested in this paper does not require the instructor to spend too much time on preparation and takes minimal classroom lecture time from students.

More important, a live case features current and real problems that real companies are facing. In discussing the value of such cases, Professor Benton E. Gup argued that live cases provide opportunity to apply finance theory to practical situations using the latest real-world data (Bruner, Gup, Nunnally, & Pettie, 1999). This hands-on approach keeps things real and interesting as new developments emerge from day to day. Moreover, live cases help students learn to use their judgment in dealing with issues rather than seeking a single "right answer" as they do in working on the end-of-chapter questions.

Of note is that although in this article we mainly discuss the use of this live-case approach in the context of classroom lectures, instructors can also easily integrate this approach and its contents into online discussion platforms. Krentler and Willis-Flurry (2005) showed that use of technology, such as online discussion

boards, enhances student learning. Therefore, our approach may contribute to both traditional and online course designs and improve student learning in various ways.

Ford Motor Company's Use of Dual-Class Share Structure

Super-voting shares were established at Ford before the company went public in 1956. According to a Forbes online article in 2010, in the mid 1930s, in planning their estate, Henry Ford and his son set up the two-class structure. The Ford Foundation, a charitable organization, received most of the shares. However, the family kept a small block of Class B shares that had voting rights (Muller, 2010). This was quite normal as most dual-class firms choose their structure prior to their IPO (Gompers et al., 2010).

However, in 1956, the New York Stock Exchange prohibited the issuance of non-voting securities. Ford tried to get around this prohibition by issuing a class with inferior voting rights rather than no voting rights. The firm's class B stock, which the Ford family owned, held 40% of the voting power; the Class A stock held the remaining 60%. This arrangement allowed the family to go public while retaining control of the company with only 5.1% equity. The relative size of the Ford family's stake has shrunk, particularly during the past few years, as the company issues new common shares, special dividends, convertible bonds, and warrants to raise capital and preserve its liquidity through the worst industry crisis in decades. However, Ford's Class B shareholders still hold 40% of the general voting power.

Figure 1 below shows Ford's stock performance from the beginning of 2008 to the end of 2013. Its performance is also compared with that of the S&P 500 and Ford's two major competitors, General Motor and Toyota Motor. While Ford recovered after 2009, obviously benefiting their stockholders, General Motor and Toyota have yet to deliver impressive performance.

As of March 13, 2013, according to Ford's proxy statement, 3,858,409,150 shares of common stock and 70,852,076 shares of Class B stock were outstanding.

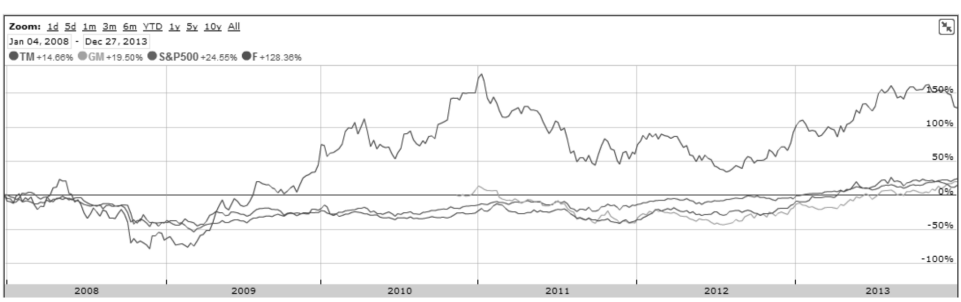

Figure 1. Comparisons of Ford Motor (F) stock performance (2008–2013) with the S&P 500, General Motor (GM), and Toyota Motor (TM). source: Yahoo Finance.

All of the over 70 million shares of Class B stock were held by the Ford family, which also held a small number of the company's common shares. At Ford's 2013 shareholder meeting, each share of Class B stock was entitled to 36.305 votes on each matter requiring a vote. This ratio is calculated as in below:

$$\frac{\text{number of common stocks} * \text{total voting power of common stock holders}}{\text{number of Class B stocks} * \text{total voting power of Class B stock holders}}$$

$$= \frac{3{,}858{,}409{,}150 * 40\%}{70{,}852{,}076 * 60\%} = 36.305$$

Following the framework summarized in Villalonga (2009a), voting rights are measured as the ratio of the number of votes associated with the shares held by the shareholder to the total number of votes outstanding in the company. Because Ford's Class B shareholders together have 40% of the general voting power in the company, we can use 40% as a proxy for the voting rights held by the Class B shareholders.

In terms of dividends (cash flow), common stock holders and Class B holders get the same amount of dividend per share. As shown in Ford's 10k statements, the dividends were 15 cents per share in 2012, 40 cents per share in 2013, and 50 cents per share in 2014, for both common stock and Class B stock. As stated previously, as of March 13, 2013, Ford had 3,858,409,150 shares of common stock and 70,852,076 shares of Class B stock outstanding. Therefore, the calculation for the cash flow rights for Class B shareholders is 70,852,076 ÷ (3,858,409,150 + 70,852,076). In 2013, this was about 1.8%. If we follow the approach suggested in Villalonga (2009a) to estimate the wedge between ownership and control in dual-class companies, the wedge is control (40%) minus ownership (i.e., cash flow right; 1.8%), which is about 38.2%. In other words, the Ford family owned approximately 1.8% of the equity but controlled 40% of the votes.

Moreover, Ford's dual class structure fits what Villalonga (2009b) described as the most common scenario among dual-class companies: The superior-voting Class B stock is privately held; the inferior-voting Class A stock is publicly held. According to Villalonga (2009b), the voting premium of the Class B shares is often assumed to be exactly offset by the discount for the lack of marketability of those shares. Thus, the two classes of shares have the same price.

TEACHING NOTES

A public company like Ford Motor Company must file a proxy statement, known as Form DEF 14A (Definitive Proxy Statement), with the SEC and send it to its shareholders before its scheduled annual shareholder meeting. The proxy statement contains important information, including voting procedures, proposals that await shareholders' votes, background information about the company's

nominated directors, board member and executive compensation, and voting recommendations regarding adoption or rejection of the proposals to be considered during the annual meeting.

Although we use Ford's 2013 proxy statement for illustration in this article, instructors may use the latest version available at the time the class is taught. This document can be downloaded for free from the SEC website. The full title of this document is Notice of 2013 Annual Meeting of Shareholders and Proxy Statement. A PDF version of this document may also be downloaded directly from Ford's Web site under the Investor Relations section.

Because the original document is more than 170 pages long, the instructor may provide students with a selection of several pages from this document instead of the entire document. Alternatively, the instructor may assign students to access and download the document and print the required pages for use in class. Doing so may help students develop their information collection skills and provide them with practical access to the website for future reference.

For our case study, we are particularly interested in the following parts:

- Questions and Answers About the Proxy Materials and the Annual Meeting (pp. 2–8) and
- Shareholder Proposals: Proposal 7 (pp. 93–94).

These contents may be related directly to topics taught in a variety of finance courses. The case study takes approximately 30 minutes and may be easily adapted into any class session. The classroom discussion is organized into two segments. The first segment focuses on background issues, including the nature of a proxy statement, shareholders' rights, and the ways in which shareholders may voice their opinions during annual shareholder meetings. The second segment focuses on the dual-class shares, including the opinions of different parties concerning the dual-class structure.

Focus 1: Shareholders' Rights

The instructor starts by leading students to read Ford's description of the purpose of the proxy statement. In this document, the company provides explanations for questions such as the following:

- "What is a proxy?"
- "What is a proxy statement?"
- "What is the purpose of the annual meeting?"

Reading through these pages will help students gain understanding about the basic concepts of corporate governance and shareholder rights in the context of Ford Company.

Instructors may use the following discussion questions to reinforce students' understanding of some of the basic concepts of shareholders' rights and corporate governance:

1. What is a proxy statement? Why do companies prepare proxy statements?
2. What kind of information is usually included in the proxy statements?
3. What is the procedure of shareholder proposals and voting process? If you are a Ford shareholder, what do you need to know about your voting rights and how to use your voting rights?

These questions also give students a practical guideline concerning the execution and limitations of shareholders' voting rights in a big public company.

Focus 2: The Dual-Class Structure at Ford

The second area of discussion focuses on the dual-class structure at Ford. As previously mentioned, in terms of dividend rights, Ford's common stocks and Class B stocks share equally in dividends when and as paid. However, in terms of voting rights, Class B stockholders have 40% of the general voting power while only owning about 1.8% of Ford's equity. Proposal 7 shows the controversy arising from the dual-class shares. This proposal to call for shareholders' votes in the annual meeting was made by an outsider investor. The board of directors also submitted its opinion and recommendation following the introduction of the proposal.

Summary of the Proposal 7. The Ray T. and Veronica G. Chevedden Family Trust (the Cheveddens) owns 500 shares of Ford's common stock. Over the years, they have repeatedly submitted proposals in shareholder meetings to urge Ford's board to adopt a recapitalization plan so that all of Ford's outstanding stock will have one vote per share. The plan includes practical steps such as negotiation with Ford family shareholders to request that they relinquish any pre-existing rights.

The Cheveddens argued that Ford's dual-class voting stock reduces accountability by allowing corporate control to be retained by insiders disproportionate to their money at risk. According to them and the articles they cited, the dual-class stock structure allows the company to raise money from shareholders but does not let shareholders have an equal voice in the company's management. The consequence of not having this voice is that shareholders cannot hold management accountable. Therefore, the Cheveddens claimed that for the

common benefit of all shareholders, it is time to change the 57-year practice (1956–2013) of disenfranchising Ford public shareholders.

Summary of the Board's recommendation. Ford's board argued that all shareholders benefit from the Ford family's significant involvement in the affairs of the company. Investors have long been aware of the dual-class structure, and Ford stocks are attractive to investors because of the long-term stability the Class B shareholders provide to the company. Ford family's involvement also contributed to Ford's survival during the recent financial crisis in which two of Ford's major domestic competitors (General Motor and Chrysler) had to go through bankruptcy.

The board also ensured investors that they are protected by the company's effective corporate governance principles. Overall, the board argued that the long history of Ford family involvement in and with the Ford Motor Company has been one of the company's greatest strengths.

Discussion questions. Instructors may use the following discussion questions to reinforce students' understanding of the structural design with dual-class stocks and the pros and cons of this design:

1. What are the (different) voting rights of Ford's common stock holders and Class B stock holders?
2. In Proposal 7, what are the arguments given by this shareholder for "Give Each Share an Equal Vote"?
3. What is the board's opinion in this issue? Why?
4. If you are a Ford shareholder, what would be your vote regarding this issue? Why?

Voting

After the discussions, instructors may call for a vote among their students. The voting results from the class may then be compared to the actual voting results from the shareholders' annual meeting, which instructors can find on the Ford's website under Events and Webcasts. Instructors should note that Proposal 7 was rejected at the May 2013 annual meeting. Of the 4,508,110,660 votes cast, 33.4% of the shareholders voted for the proposal; 66.6% voted against it.

Instructors may also share with students that they can find the same proposal in Ford's proxy statements from previous years, initiated by the same investor/shareholder. It seems that although the Cheveddens continue to fight for the same cause over the years, they have not yet managed to get a majority of the votes. We will not be surprised if we see the same proposal awaiting the vote of shareholders in next year's annual meeting.

SUMMARY

Using case material from a real company can enhance students' understanding of important corporate finance subjects such as corporate governance and shareholders' rights. These cases motivate students to go beyond the theories and concepts introduced in textbooks to understand what is actually happening in today's corporate world. In this paper, we have introduced a short live case simple enough to be smoothly integrated with classroom lectures. This teaching technique allows instructors to keep classroom discussions close to both lecture subjects and current corporate practices in the real world.

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Are Classroom Games Useful for Teaching 'Sticky' Finance Concepts? Evidence from a Swap Game

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Despite a long list of documented games in economics and other disciplines, the lack of literature on experiments in finance teaching suggests that academics in the field of finance may have been slower to embrace the benefits of experimental learning than academics in other fields. This paper contributes in closing this gap. Firstly, it documents an example of a role-play game, which might be used in teaching a 'sticky' concept of swaps. Secondly, the paper discusses students' experiences of the game and provides a summary of the survey results. Finally, the paper contributes to the thin literature of experimental learning effectiveness by presenting evidence on how the participation in the experiment affected learning outcomes in the particular topic.
Keywords: *experimental learning, in-class games, role-playing, finance, swap*

INTRODUCTION

The literature on economic and finance pedagogies is extensive, with publications describing, summarising and critiquing various methods of teaching from the traditional lecture to modular learning, the case method, an experiential and game approach, computer-assisted instruction and tablet technology, while other articles have taken on the task of presenting ways to better explain finance concepts to students (Vihtelic, 1996). For example, Horvath (1985) and Kochman (1986) look closer at the concept of discounting, while Dyl (1991), Chan, Weber and Johnson (1995) and Graham and Kocher (1995) show how popular movies assist students to better understand introductory finance concepts. Similarly, Lange (1993) and Yoon (1995) describe how financial concepts can be presented using spreadsheets,

while Lawrence (1994) details the case of how students' learning benefits from establishing real as opposed to simulated investment funds in universities. The economics discipline also frequently uses experiments and games to illustrate concepts such as supply and demand, auctions and externalities (Bergstrom & Miller, 2002). Brauer and Delemeester (2001) present an extensive compilation of 113 classroom games in the areas of microeconomics and macroeconomics, highlighting their overall strengths and weaknesses as well as some of the costs and benefits to the students and instructors. The use of experiments in finance teaching has been somewhat less well documented. The list of described games/ experiments in finance is rather small and their effectiveness as teaching tools is largely unexplored.

The paper aims to fill the gap in a number of areas. Firstly, it compiles a list and brief descriptions of the existing in-class experiments in finance from the academic literature. Secondly, it offers a description of a swap role-play game and, therefore, adds to the catalogue of experimental finance teaching literature. The motivation for the use of a game came from the desire to address the difficulty students experience in learning the basics of swaps. The game was designed and implemented by the authors in a second year undergraduate finance course. Thirdly, the paper adds to the literature in describing students' perception of role games as an alternative/supplement to the traditional teaching methods. Finally, the paper investigates whether the game we employed was effective in helping students to understand the concept of the swap instrument.

The rest of the paper consists of five sections. Section 2 outlines the motivation for experimental teaching and catalogues the literature on in-class experiments and games in teaching finance. Section 3 describes a swap game as it was implemented in an undergraduate course at Griffith University. Section 4 focuses on the evaluation of students' experience with the role-play. Section 5 empirically analyses a potential link between students' performance in the swap question they attempted in the examination and in their participation in the game. The paper concludes with Section 6.

Why experiment?

The reason why there is a need for different methods of teaching is that individual students have different learning styles. While it is commonly known among academics that some students tend to be 'concrete' learners and others are more 'abstract' learners, Gardner (1983) identified seven kinds of intelligence: verbal/linguistic, logical/mathematical, spatial, interpersonal, intrapersonal, bodily/kinaesthetic and musical. The traditional classroom teaching style tends to emphasize the first two intelligences and, accordingly, students who learn best by speaking, writing, reading, calculating, questioning and experimenting will benefit most from these approaches (Grinder et al., 1999). Thus, other types of educational

experiences are needed to cater for those students that are visual, interpersonal or intrapersonal learners. Furthermore, instructors must also take into consideration the fact that students learn at different cognitive levels. In his seminal work, Bloom (1956) identifies six levels of cognitive domains: knowledge, comprehension and simple application, demonstrated typically in introductory courses, and higher understanding levels such as application, analysis, synthesis and evaluation, which are conveyed in more advanced courses.

In the field of finance and economics, teaching the concepts, theory, mathematics and its applications can be challenging at times. Instructors need to adapt their methods to address not only the continual changes in the mission of universities where generic student skills are strongly emphasised, but also the changes to students' expectations in the classroom (Hawtrey, 2007). The last decade has seen a shift from the traditional teaching methods towards experiential learning that includes an active, participatory learning style aimed at improving student motivation, better retention of knowledge and understanding of the content through an enhanced classroom experience (Vihtelic, 1996).

Experiential learning has been found to be one of the preferred learning activities in finance and economics as students are transformed from passive listeners to active participants, engaged in communicating opinions and working in teams (Hawtrey, 2007). Experiential Learning Theory (ELT) is built on six propositions based on the work of prominent scholars like Kurt Lewin, Jean Piaget and others, who place 'experience' at the centre of their theories of human learning and development (Kolb & Kolb 2005). In the context of ELT, Kolb (1984, p.41) describes learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience." The ELT model combines the modes of grasping experience—Concrete Experience (CE) and Abstract Conceptualisation (AC), with the modes of transforming experience—Reflective Observation (RO) and Active Experimentation (AE). Thus, an experiential learning sequence is created where the student applies and adapts these four modes - experiencing, reflecting, thinking and acting - to the learning context and situation at hand. Among the principles proposed to enhance the experiential learning in higher education, Kolb and Kolb (2005) suggest that learning should incorporate more the practices of expressing, demonstrating, applying and critiquing.

Similarly, Hawtrey (2007) suggests that the key element in experiential learning is the personal involvement of the student in the learning process, where learning becomes the product of a practical, personal, thoughtful and lived experience. This is quite different from the traditional 'chalk-and-talk' approach style of teaching that relies on the instructor to describe the theories and concepts and the student to 'take in' the information presented. Another reason for the shift towards active learning is that students remember only a small part of what they hear but they remember a greater part of what they do.

While Kalogeras (1976) defends the traditional lecture method of instruction, Branch (1975) shows that using games in teaching concepts of investing has been successful in stimulating student interest in the subject. Butler (1988) finds that games develop problem-solving competences and help students with their self-confidence, while Whitney (1990) states that through games, instructors reach to students' fundamental level of learning to develop progressively the concepts necessary for total understanding.

Games, simulations and role-play have been used as teaching aids for decades in the finance and economics disciplines. Alden (1999) and Oberhofer (1999) argue that these teaching techniques encourage students to reflect on their knowledge, while Francis and Byrne (1999) emphasize the benefit of simulations, games and role-play in uncovering 'sticking points in student understanding' (p.209). Not only do these techniques allow students to develop a greater appreciation of role and responsibility (Freeman & Capper, 1998), but they can also bring life and relevance to abstract and theoretical content (Lowry, 1999).

Despite the overwhelming literature in support of experimental and experiential learning, in contrast to the long list of classroom games in economics, the literature on experimental learning in finance discipline teaching is rather limited. There are only a small number of games applicable to finance teaching described in the literature and there is practically no evidence about how enjoyable or useful those games were. Table 1 presents a summary of published articles where games and experiments have been used in teaching finance concepts, showing the student response and feedback to this form of teaching and whether or not these techniques were effective in improving student learning. The small number of publications clearly suggests a gap in the literature. This paper contributes to closing this gap by describing the role-play experiment used in teaching the concept of swap instruments and their hedging application.

Description of the swap game

Over the years of our experience in teaching various risk management tools for financial institutions, as a part of reflective teaching practices and through quality assurance we noticed a considerable difficulty that students encountered in understanding the nature and mechanics of swap instruments. Quality assurance processes, which were set to assist with meeting Association to Advance Collegiate Schools of Business (AACSB) accreditation requirements, helped us in identifying discrepancies in the quality of answers for swap and other questions in the end-of-semester assessments. We found that in the examinations where swap-based questions were optional, the 'take-up' rate of a swap question was typically lower than questions from other topics. Moreover, the quality of responses was also inferior with the average mark for the questions around 20% lower to other questions with the similar weight. As a part of reflective teaching practice, the

Table 1. Survey of games and experiments in finance.

Publication	Nature of Experiment/ Game	Students' Feedback	Effectiveness of Method	Other Findings
Kassis, Hazlett & Ygosse Battisti (2012)	The experiment explains the role of banks as financial intermediaries and shows how risk affects market interest rates in the presence of asymmetric information, as well as illustrating the concept of diversification and issues associated with the moral-hazard problem of deposit insurance.	Not presented, however students perceived the game experience as fun and exciting.	Not formally assessed. A debriefing discussion encouraged the students to discuss how each role influenced the outcome of the experiment.	The experiment can be run with small classes or with those as large as 75 students.
Dicle & Levendis (2011)	A computerised instructional and assessment trading game where students can buy and sell stocks, options, futures, mutual funds and ETFs, place market and limit orders, trade international stocks, set up different portfolios and set up options trading strategies.	Favourable student comments in teaching evaluations.	Not assessed	Timely feedback tailored to each student plays an important role in the effectiveness of teaching.
Flanegin, Zapalska, Rudd & Litzinger (2010)	Students act as foreign exchange traders having the task of rebalancing and hedging foreign exchange currencies, thus betting on forward and spot rates. The game allows students to observe the strategic behaviour involved in buying and selling, the role of market forces in determining equilibrium prices and provides the experience of planning and implementing hedging strategies.	Not presented	Not formally assessed, however a debriefing session at the conclusion of the game was used to reinforce and enhance the effectiveness of the learning experience through the game.	The game emphasizes higher order learning such as problem-solving and active learning through real world scenarios.

Table 1. (*Continued*).

Publication	Nature of Experiment/ Game	Students' Feedback	Effectiveness of Method	Other Findings
Adams & Kluger (1998)	The game illustrates the concepts of arbitrage, risk and diversification through trading of multiple risky assets and one riskless asset.	Favourable student comments from both undergraduate and MBA teaching evaluations.	Not assessed	The experiment can be run with both individuals and teams.
Cooper & Grinder (1997)	The Black-Scholes option pricing model and put-call parity is used in an interactive Excel spreadsheet game to price options. The game emphasises the factors that cause changes in option prices and the real life limitations of mathematical models.	Positive student feedback showed greater enthusiasm for such an intimidating subject matter.	Not assessed, however a debriefing session at the end of the game discussed the strategy of the winner, highlighting the concepts of market efficiency and risk.	The game must be played for at least two or three iterations for the students to develop an understanding of the option valuation concepts.
Bell (1993)	An asset trading game consisting of three sequences of eight trading rounds where students buy and sell shares of an imaginary financial asset. Students convey their own prices which compels them to apply asset valuation theory and statistics.	Greater class interest and participation.	Strong correlation between student performance in the trading game and performance on tests and written assignments.	To be used only as a supplement to any investment course.
Shrader & Helgeson (1993)	A multi-period double oral auction game consisting of two assets, non-income-earning cash and stock-like certificates, where students trade these assets in order to increase profits.	Students found the experiments fun, stimulating and informative with no statistical difference between the non-monetary and monetary incentive groups.	Not formally assessed, however the authors found that these experiments had a positive effect on student learning experience for the remainder of the course.	Limit the number of participants to 15-20 students.

authors decide to refer back to the literature on experimental teaching. As a result of studying prior research in this field, two conclusions were drawn. Firstly, experimental teaching was considered a viable option and worth pursuing and, secondly, there were no documented experiments related to swap topics. As a result, the first step was to design a role-play game focusing on basic plain vanilla swap and its hedging applications.

The game design started with identifying what were the most important points we would like our students to understand from the swap topic. The first goal was to enable students to understand how a 'stand-alone' basic plain vanilla swap works. The second goal was to show students how interest rate volatility (interest rate risk) might impact upon financial institutions if positions were left unhedged. The third goal was to show how swaps assist financial institutions in hedging interest rate positions. To address each of these, an individual scene was set for each goal; participant lists and game tools (including paper money, cheques, labels and instructions to each participant) were prepared.

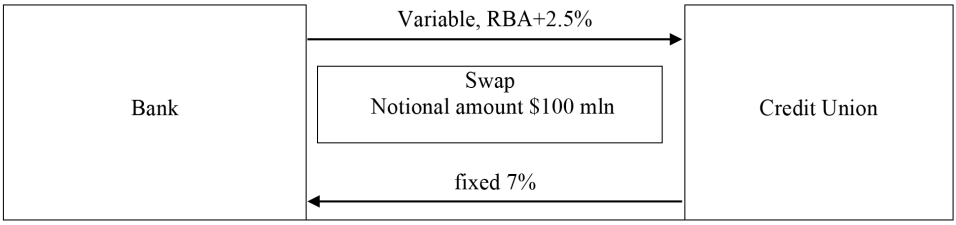
Experiment 1. How does a plain vanilla swap work?

Three students were required to participate in the experiment in addition to the instructor who directed the experiment. The participant roles were represented by a bank, a credit union and a central bank (or any variable interest rate benchmark announcer).

The bank was assumed to have variable rate assets and fixed rate liabilities, the credit union was assumed to have fixed rate assets and variable rate liabilities; the central bank, the Reserve Bank of Australia (RBA) in our case, was used as a provider of the basic variable rate benchmark (RBA cash rate).

The instructor then introduced the concept of swap and offered the participants and the audience to play/observe the mechanics of the swap. The characteristics of the swap were suggested by the instructor including the notional amount, the swap rate and the position of the bank and credit union, which represented the seller and buyer of the swap respectively. The initial variable rate benchmark was set in the manner that no payments would be required on the swap if the interest rate remained unchanged.

The freedom was given to the student representing the RBA to set a cash rate in the next period. The student chose a rate and announced it to the audience. The instructor briefly speculated under what conditions the interest rate could rise or fall and provided an explanation of the working for the outstanding payment on the swap. If the interest rate increased, the bank would then write a cheque for the outstanding amount (net payment) and pass it on to the credit union. Conversely, the credit union would write a cheque and pass it to the bank if the interest rate decreased. The experiment was repeated three times using various interest rate levels and accompanied workings. The students representing the RBA were



RBA rate	*Cash flow*	*Direction*
Initial - 4.5%		
Period 1 - 5%	5% + 2.5% -7% = 0.5% 0.5%*100mln = $0.5mln	Bank pays Credit union $0.5mln
Period 2 – 4.5%	4.5% + 2.5% -7% = 0	No cash flows
Period 3 – 3.9%	3.9% + 2.5% -7% = -0.6% -0.6%*100mln = -$0.6mln	Credit Union pays Bank $0.6mln

Figure 1. Example of calculations in Experiment 1—plain vanilla swap.

instructed to show that the interest rate could fall, rise, or remain the same, so that the students could appreciate all scenarios related to holding the swap. The main message to the students was to show that a swap is an instrument for which the direction and size of its cash flows are uncertain and depend on the benchmark interest rate fluctuations. An example of the workings is presented in Figure 1.

Experiment 2. Impact of interest rate volatility on financial institutions' net interest income.

Seven participants were required for the second experiment in addition to the instructor. These were comprised of a bank, a credit union, a central bank, a bank depositor/lender, a bank borrower, a credit union lender/depositor and a credit union borrower. The rest of the audience was divided into two groups, shareholders of the bank and members of the credit union, who would evaluate the performance of the unhedged financial institutions at the end of each experimented year. The assumption about the bank's and the credit union's position remained unchanged from Experiment 1.

The instructor introduced both financial institutions' balance sheets and income statements. For simplicity, the assumption made was that the values of asset/liability positions were equal to the notional value of the swap in Experiment 1.

In year 0, students were clearly shown their Net Interest Income (NII) based on the current RBA rate (it was set as positive for both institutions in year 0). A student playing the role of the RBA was asked to write higher, lower and unchanged interest rates in years 1, 2 and 3 at random. The instructor showed on the visualiser the workings for the payments due to and from each of the two

RBA rate	Bank		Credit Union	
	Assets Loans, 9% fixed $100mln	*Liabilities* CDs, RBA+2.5% variable $100mln	*Assets* Mortgages, RBA+3% $100mln	*Liabilities* Deposits, fixed 6% $100mln
5%	NII=9%*$100-(5%+2.5%)*$100=$1.5mln		NII=(5%+3%)*$100-6%*$100=$2mln	
4.5%	NII=9%*$100-(4.5%+2.5%)*$100=$2mln		NII=(4.5%+3%)*$100-6%*$100=$1.5mln	
3.9%	NII=9%*$100-(3.9%+2.5%)*$100=$2.6mln		NII=(3.9%+3%)*$100-6%*$100=$0.9mln	

Figure 2. Example of calculations in Experiment 2—Unhedged balance sheet positions.

financial institutions. Paper money was used to show the flow of cash from and to each of the institutions and their lenders and borrowers. The net interest income was calculated for each institution based on their performance; shareholders (rest of the audience) were encouraged to express their approval or disapproval of the performance of each of the financial institutions.

The main message emphasised that without hedging, both financial institutions were unprotected against the negative impacts of interest rate changes. An example of the workings for Experiment 2 is presented in Figure 2.

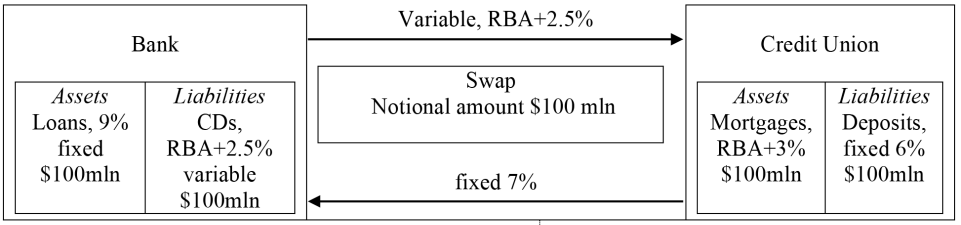
Experiment 3. Hedging with the plain vanilla swap

The third experiment was considered the pinnacle of the role game as it clearly shows how combining a balance sheet position and a swap instrument creates a hedged balance sheet position. Experiment 3 required exactly the same number of players and roles as in Experiment 2. For consistency purposes, the same interest rates were used as in Experiment 2 and the same swap rate as in Experiment 1.

The instructor had an important role to manage the cash flow movement and to show the workings that emphasised the point of reduced volatility of the position (zero volatility in our experiment). An example of the workings is presented in Figure 3.

Did students like it?

The role-play game described above was implemented in a second year undergraduate course, 'Financial Institutions Management.' Griffith Business School has a policy of recording lectures (screen and voice) which means that the experimental class recording was available to students. Moreover, the students



RBA rate	Bank	Credit Union
5%	NII=9%*$100-(5%+2.5%)*$100+ (5%+2.5%-7%)*100=$2mln	NII=(5%+3%)*$100-6%*$100+ (7%-(5%+2.5%))*100=$1.5mln
4.5%	NII=9%*$100-(4.5%+2.5%)*$100+ (4.5%+2.5%-7%)*100=$2mln	NII=(4.5%+3%)*$100-6%*$100+ (7%-(4.5%+2.5%))*100=$1.5mln
3.9%	NII=9%*$100-(3.9%+2.5%)*$100+ (7%-(3.9%+2.5%))*100=$2mln	NII=(3.9%+3%)*$100-6%*$100+ (7%-(3.9%+2.5%))*100=$1.5mln

Figure 3. Example of calculations in Experiment 3—Hedging financial institutions' positions with a swap

were given an access to a pre-recorded traditional lecture. The time allocated for the game was one academic hour, as this was the second half of the lecture related to use of derivatives to hedge interest rate risk. Students were advised at the beginning that in the second half of the lecture there will be a role-play game and they would have an option to attend or not. Moreover, they were advised that a recording from the traditional lecture would be made available for their use.

The announcement that the traditional lecture was to be replaced by a game was not well received by some students. Roughly, half of the class opted to leave after the first hour and skipped the experiment. Those who remained were asked to register their names. Thirty-eight students signed the class roll.

The experiment generally went well. Students were asked to volunteer for various roles and the available roles were filled quickly. Those students who missed one of the seven most active roles were asked to split into equal groups to become shareholders/members of two institutions. Students appeared to be engaged in the game and actively participated in the experiment. In the role-play itself, opportunities for further fine-tuning were discovered. For example, the game had five interest rate scenarios for each experiment, which somewhat slowed the dynamics of the game. In the future, perhaps a smoother transition between cases would happen if the experiment were to be limited to three scenarios only. Opportunities to create more active role for the audience should also be explored. One option could be asking the audience to act as 'auditors' and calculate hedged cash flows under scenario 3. Furthermore, a need for a better pre-game brief for the active participants was also noticed.

Students were asked to fill in a simple optional questionnaire about their experience with the role- play game. Six 5-point Likert scale questions were offered to students, together with one open question to share any other observations/ comments from the game. The questions are as follows:

1. Have you enjoyed the experience of the 'Swap Role-Play' game?
2. Do you recommend using the 'Swap Role-Play' game again in the future?
3. Would you like similar experiments in other lectures/courses (instead of traditional lectures/tutorials)?
4. Do you think you understand better the nature of the swap instrument as a result of this experiment?
5. Do you think you understand the concept of hedging using swap contracts in the context of financial institutions as a result of this experiment?
6. Would you prefer to have had a traditional type of a lecture today instead of an experiment?

For each question, students had five options to choose from, with each option allocated a score as follows: strongly no (score 1), marginally no (score 2), neutral (score 3), marginally yes (score 4) and strongly yes (score 5). There was an additional space at the bottom of the survey where students were encouraged to share their thoughts of the game, i.e. what went well, what did not, what can be done better? Out of the thirty-eight students who participated in the experiment, twenty-eight students opted to fill in the questionnaire. The results are presented in Table 2 below.

Table 2. Role-play game students' feedback survey results.

Answer (score)	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Strongly yes (5)	75.00%	64.29%	60.71%	78.57%	46.43%	0.00%
Marginally yes (4)	7.14%	32.14%	28.57%	17.86%	39.29%	0.00%
Neutral (3)	17.86%	3.57%	10.71%	3.57%	10.71%	14.29%
Marginally no (2)	0.00%	0.00%	0.00%	0.00%	3.57%	46.43%
Strongly no (1)	0.00%	0.00%	0.00%	0.00%	0.00%	39.29%
Average score	4.68	4.61	4.50	4.75	4.29	1.75

As is evident from the answers in the survey, practically all students enjoyed the experience of the game and believed there are positive outcomes for their learning. This is well in line with the existing literature (see Table 1 for the comprehensive list of finance experiments and some economics experiments), which overwhelmingly reports a positive experience for those students who were involved in experimental learning. More positive results are observed for the enjoyment and understanding of the simple concept. Question 4, which relates to a more complex concept, reports slightly less positive outcomes, which is logical. Students recommended using games/experiments more often in the classes. The

average score in Table 2 represents the arithmetic average score for each question in the twenty-eight available questionnaires.

The open comments were in line with the findings of the survey where they expressed satisfaction and enjoyment of the game. Some of the students did report a difficulty with understanding the third experiment, which might have been expected taking into account the higher complexity of the concept. Some suggestions were made by students to reduce a number of interest rate scenarios for each experiment in order to maintain good dynamics within the game.

We were encouraged by the results of the survey, although we recognised that they should be treated with caution due to a potential 'self-selection bias.' The students who stayed in class for the role-play might be more open to experimental types of learning, as opposed to those who might prefer traditional lectures and chose to leave the class before the start of the game.

Overall, the findings of this paper add to the evidence that in-class experiments are enjoyable and fun for the participants; they benefit students and instructors in terms of breaking the routine and they improve the reputation of finance teaching among students. The shortcoming of the experiment was the lack of willingness by some students to play the game with serious intent. These findings are generally in line with the summary of findings made by Brauer & Delemeester (2001).

Was the game useful?

While the use of experiments and games as teaching tools has been shown to be useful in enhancing the classroom experience of students, Fels (1993) and DeYoung (1993) have questioned whether these techniques have been useful in terms of their pedagogical effectiveness.

Recent studies in economics that have attempted to measure the effectiveness of experiments, show encouraging results. Durham, McKinnon & Schulman (2007) analysed the performance of students enrolled in micro- and macroeconomics to find that classroom experiments enhanced the educational experience of students, irrespective of learning styles. They found that students performed better in the exam questions covering the topics explored in the experiments. Furthermore, they found that experiments improved students' attitudes towards studying economics and increased their retention of knowledge. Using Test of Understanding in College Economics (TUCE) scores to measure the effect of experiments and controlling for student aptitude and other variables, Dickie (2006) showed that experiments aid learning and that the use of grade incentives offsets this benefit. Similarly, Gremmen and Potters (1997) have reported that in-class game exercises have had a positive impact on learning. They indicated that experiments help the student to retain knowledge more easily and that they have a permanent influence on understanding the concepts involved. Testing whether in-class experiments differ from online experiments in enhancing student achievement, Carter &

Emerson (2012) do not find a significant difference between the two methods of teaching. Although students viewed in-class games more favourably, their learning outcomes were no different from those of the students exposed to computerized experiments, indicating that the social interaction of a face-to-face presentation is more enjoyable.

The research by Bell (1993) into finance discipline is the only one that has attempted to assess the effectiveness of the in-class experiment. The study found a strong correlation between the performance in the trading game and the performance in the assessment items. However, Bell's study did not assess whether the trading game had been effective in enhancing students' learning outcomes in comparison to traditional methods.

A summary of the studies in economics and finance that estimated and reported the effectiveness of the games/experiments is presented in Table 3 below.

Table 3. Experiments in finance and economics and their effectiveness on students' performance and learning

Publication	Nature of Experiment/ Game	Students' Feedback	Effectiveness of Method	Other Findings
Bell (1993)	An asset trading game consisting of three sequences of eight trading rounds where students buy and sell shares of an imaginary financial asset. Students convey their own prices which compels them to apply asset valuation theory and statistics.	Greater class interest and participation.	Strong correlation between student performance in the trading game and performance on tests and written assignments.	To be used only as a supplement to any investment course.
Frank (1997)	A five to ten minute experiment demonstrating the 'tragedy of the commons' dilemma involving five volunteer students, conducted by seven instructors teaching courses in environmental economics or public finance. Multiple-choice test questions on the topic were answered by students participating in the game and by a control group.	Not formally requested, however casual feedback received after the lecture was encouraging.	Correct answers in the test were significantly higher in the experimental groups than in the control groups. What remains unclear is whether taking part in the experiment is more beneficial than just watching it.	The benefits of the experiments can be underestimated if they are not preceded or followed by discussion or interpretation of a problem.

Table 3. (*Continued*).

Publication	Nature of Experiment/ Game	Students' Feedback	Effectiveness of Method	Other Findings
Gremmen & Potters (1997)	A multi-day international economic game explaining topics such as inflation, employment and exchange rates among others. Pre-test and post-test results on the group of students who played the game are compared with the results of students following a traditional lecture style.	Both groups of students perceived the lectures to be slightly more beneficial to their learning than the game.	Both groups scored the same on pre-test results while the students playing the game scored significantly higher than the lecture group on the post-test assessments.	Before and after multiple-choice test results show no systematic or significant correlation between what students believe they learned from the game and what they actually learned.
Dickie (2006)	A controlled experiment on learning microeconomic concepts to test the efficacy of experimental teaching. The pre-test and post-test of two experimental groups (with and without grade incentives), are compared with those of a control group. The difference between post-test and pre-test scores is considered as the measure of achievement or learning.	Students enjoyed participating in the experiments, with 75% of students indicating that experiments were more interesting than lectures.	The use of class experiments was linked to a significant increase in mean student achievement. The grade incentive to reward performance had no impact on learning.	Class experiments provide greater benefit to high achieving and younger students, and those with more college experience.

Table 3. (*Continued*).

Publication	Nature of Experiment/ Game	Students' Feedback	Effectiveness of Method	Other Findings
Durham, McKinnon & Schulman (2007)	Multiple experiments conducted over three years on 1,585 students from 16 class sections in introductory microeconomics and macroeconomics courses. The effect of classroom economics experiments on student learning was tested using the relative performance of the control and the treatment group based on the results of the mid-term and final exams.	The experiments generated enthusiasm among the students and a better class atmosphere. A survey on attitude towards economics showed that students in the control group expressed an improved attitude towards studying economics.	Controlling for factors like learning styles, attitude, instructor, time -of -day and time-on-task, the overall results showed that classroom experiments had a positive effect on student performance. The larger impact was seen in the macroeconomics concepts.	Multimodal or kinaesthetic learners benefit more from experiments than from lectures, while read-writer learners are not significantly affected by experiments. Experiment participants retain more knowledge of the concepts taught than those in the control group do.
Carter & Emerson (2012)	Microeconomics in-class experiments are compared with ones delivered online to determine the difference in student achievement as measured by the course scores and Test of Understanding in College Economics (TUCE) (Saunders 1991).	Students preferred the in-class experiments more, experiencing higher level of interaction with peers.	No significant difference in student achievement between the online group and the in-class group.	The choice of in-class versus online makes no difference to the general evaluation of the course.

As noticed from the literature reviewed above, the evidence of effectiveness of the games on students' learning is thin and equivocal, albeit never negative. Therefore, it was much harder for the authors to predict the outcome of the next question we asked ourselves: whether the experiments are effective, or not, as learning tools. We kept an open mind and were happy to accept any outcomes whatever they happened to be. We adopted a two-step analysis of the students' performance. Firstly, we looked at the interaction between attendance of the role-play class and students' willingness to attempt the swap question in the final exam. The purpose was to see whether attending the class gave students more confidence to attempt the optional swap question in the exam at the expense of other optional

topics. The exam included a range of compulsory multiple-choice questions with a 20 per cent aggregate weight and five multi-step written problems, where students had an option to choose four (20% weight each). One of those elective questions was on swaps. The analysis has found no significant difference in the take-up rate on the swap question between students who attended the class and those who did not. In particular, 57.89 per cent of those who attended the role-play game lecture attempted the swap question, whereas for those who did not attend the class, the take-up rate was 57.6 per cent. It appeared that attendance of the role-play class has not played an important role in deciding to pick the swap question or not. The take-up rate for the swap question was still smaller than with any other four questions from other topics, which confirmed the relative difficulty of the topic.

Secondly, we empirically tested whether participation in role-play game class had contributed to the performance of the ninety-four students who picked the swap question in the exam. For that, we ran a simple Ordinary Least Squares regression:

$$y_i = a + bx_i + d_i + \varepsilon_i$$

where y_i is a proportion of the maximum mark in the swap question, x_i is a control variable represented by a proportion of the maximum mark in the rest of the exam and d_i is the dummy for the role-play game class participation. The proportion of the maximum mark in the rest of the exam was chosen as a control for the effect of students' general exam preparation effort and individual abilities. The regression results are reported in Table 4 below.

Table 4. Regression results on the effectiveness of the swap role-play game.

Variable	Coefficient	P-value
Intercept	-0.24	0.005
Control variable	1.21	0.000
Attendance dummy	0.15	0.012
R-squared	*0.513*	
Adjusted R-squared	*0.502*	

As expected, the control variable proved to be highly significant showing that students' preparation and abilities played a very important role in their swap question performance. The negative value of the intercept reflects the fact that performance on the swap question was, on average, lower than in the rest of the exam (50.47% versus 58.59%).

The main aim of this empirical test was to find out whether the participation in the in-class experiment improved students learning outcomes. Since all students enrolled in the course had an access to video-recorded traditional lecture, the outcome of participation dummy could tell us whether role-play game had additional benefits for students learning. We found that participation in the role-play

game has indeed helped students to achieve better learning outcomes. Participation dummy is positive and highly significant (98.8% level) with the coefficient equal to 0.15. This means that, on average, the attendance of the role-play game added 15 per cent to the performance in the swap question.

Unfortunately, the technology at the time of experiment did not allow us to trace which students accessed the recorded classes in their study and exam preparation; therefore we were unable to undertake more detailed analysis to isolate the effect of recorded video. Despite this minor deficiency, the result is still rather convincing in support of the argument that participation in the experiment enhanced students' learning outcome for the swap question.

CONCLUSION

Experimental learning has been part of the educational landscape for decades. Although it shows some promising outcomes, it has not become a mainstream education strategy. Instead, it is often used as an alternative and complimentary method when traditional methods do not deliver satisfactory results.

In this paper, we have attempted to answer three questions. Firstly, we reviewed the literature to find out whether experimental learning can offer a solution to assist undergraduate students to tackle, more effectively, the relatively difficult concept of swaps and hedging with swaps. During the process, we examined the theory behind the experimental learning to ensure that experimental learning is a valid alternative to traditional teaching methods. We also documented existing games/ experiments in finance and discovered that there were no suitable games to assist us. With no answer from the existing literature, we designed a role-play game, which was implemented in a second year undergraduate course. Secondly, the question addressed was whether or not the experiment conducted was enjoyable for the students and whether or not it was a useful tool for engaging more effectively with the students. The answer was a resounding 'yes' for the group that participated in the experiment. However, since not all students took part in the game, it was impossible to get a broader view of this type of activity from the students who responded to the survey. The final question we examined was whether the experiment we conducted was enabling students to become more successful at answering the swap assessment topic or not. Since the existing literature was limited in this field, we approached the question with an open mind and were prepared for any outcomes. The results of the empirical test conducted showed that attendance and participation in the role-play game was indeed beneficial for the students, with results showing enhanced learning outcome were sizeable and significant. Students who engaged in the role-play game performed, on average, 15 per cent better than the students who did not, after controlling for their abilities and preparation efforts.

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Bringing the Global Financial Crisis Alive in the Classroom

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This paper describes how two movies, Inside Job *and* Too Big to Fail, *one a documentary and the other a dramatization, can be used in the classroom to bring the global financial crisis alive in ways that would be difficult to achieve in more traditional ways, such as lectures, readings, and cases.*
Keywords: *finance documentaries, film in the classroom, global financial crisis, finance movies*

INTRODUCTION

A variety of pedagogical strategies can be used to teach finance, such as lectures, readings, cases, and simulations. While each teaching method has its benefits and limitations, it is clear that students cannot learn unless they are sufficiently stimulated. Teaching finance poses the challenge of connecting theories and models to the "real world" and providing students with an organizational frame of reference that helps them understand and appreciate the relevance and context within which the subject matter applies. Students, especially undergraduates, do not have the business experience and organizational context within which to place much of what is learned in the classroom. This is especially the case when studying the managerial motivations (e.g., personalities, egos, and greed) surrounding strategic decisions such as corporate takeovers and proxy fights or malfeasance such as insider trading and fraud.

Over the years, I have found that movies can be an effective way to stimulate student interest in the classroom. I use two movies, *Inside Job* and *Too Big to Fail,* in my undergraduate Cases in Corporate Finance course to bring life to the events leading up to and causing the global financial crisis and its aftermath. This article discusses these movies and my experience over several years integrating them into my course. After a review of the literature, the article provides overviews of each movie followed by a discussion of the benefits and limitations and a summary of student feedback. The article ends with concluding comments. Summaries of the movies and suggested questions for classroom discussion are presented in the Appendices.

This article should be of interest to instructors who are considering using movies in the classroom as a pedagogical strategy and two movies in particular that focus on the global financial crisis.

LITERATURE REVIEW

There is a growing literature on the use of movies in the finance classroom. For example, Nofsinger (1995), Peterson and Philpot (1997), and Kester (2013) describe how *Barbarians at the Gate* can be used to stimulate discussions of a variety of issues related to the takeover battle and leveraged buyout of RJR Nabisco, including company valuation, ethics, and social responsibility as well as the effects of greed and egos in the world of finance. The use of *Wall Street* as a "live case" to discuss legal and ethical issues in finance is described by Dyl (1991) and Beldon (1992). Hatfield & Buchko (2008) discuss how the academy award-winning documentary, *Enron: The Smartest Guys in the Room*, can enliven discussions of the financial and ethical issues related to this well-known and publicized story of fraud and bankruptcy. Chan, Weber and Johnson (1995) and Graham and Kocher (1995) describe how *Other People's Money* can be used as a case study in hostile takeovers, corporate responsibility, business ethics, and gender stereotypes. These movies along with *Boiler Room*, *Rogue Trader* and *Glengarry Glen Ross* are also described by Kester, Cooper, Dean, Gianiodis, and Goldsby (2012) as valuable resources for teaching ethics to business undergraduates that help student place ethical dilemmas in a broader and richer context. Other movies described in the financial education literature include *Trillion Dollar Bet* (Fairchild & Grayson, 2004) that chronicles the rise and fall of Long-Term Capital Management and the holiday favorite, *It's a Wonderful Life* (Philpot & Ogelsby, 2005). Goebel, Athavale & Weber (2016) summarize and provides discussion questions for 21 dramatic films and five documentaries with finance themes.

Whether fictional (*Wall Street, Boiler Room*, *Other People's Money,* and *It's a Wonderful Life*), dramatizations based upon actual events (*Barbarians at the Gate*, *Rogue Trader,* and *Too Big to Fail*), or documentaries (*Enron: The Smartest Guy in the Room*, *Trillion Dollar Bet*, and *Inside Job*), movies capture students' attention, provoke thought, and stimulate discussion. As noted by Serey (1992), students prefer visualization over passive learning approaches to understand concepts. Students develop deeper understanding of topics covered in class through their application to a movie's characters and situations. Of course, movies are not substitutes for traditional pedagogy tools. However, they can be used selectively to enhance learning and insight in more traditional lecture and case courses in finance.

THE MOVIES

Inside Job

The caption at the beginning of *Inside Job* says that the "global financial crisis of 2008 cost tens of millions of people their savings, jobs, and their homes. This is how it happened." The academy award-winning 2010 documentary explores changes in the regulatory environment (or lack thereof) and banking practices related to mortgage lending, loan securitization, derivatives, and employee compensation that led to a bubble in the housing market, the bankruptcy of Lehman Brothers, the liquidity crisis at American International Group (AIG), the government takeover of Fannie Mae and Freddie Mac, the acquisition of Merrill Lynch by Bank of America, the Troubled Asset Relief Program (TARP), and the near-collapse of the financial system. The movie was produced, written, and directed by Charles H. Ferguson and narrated by actor Matt Damon. After a 12 minute introduction, including an overview of the deregulation and collapse of Iceland's banking system and economy, the documentary is divided into five parts: I. How We Got Here, II. The Bubble (2001-2007), III. The Crisis, IV. Accountability, and V. Where We Are Now.

The documentary includes interviews with a variety of participants, policymakers and observers, including Paul Volcker, former Chairman of the Federal Reserve System, Eliot Spitzer, former Governor of New York, Barney Frank, Chairman of the U.S. House Financial Services Committee, Christine Lagarde, Finance Minister of France (and current Managing Director of the International Monetary Fund), Scott Talbott, Chief Lobbyist of the Financial Services Roundtable, Gillian Telt, U.S. Managing Editor of *The Financial Times*, Glenn Hubbard, former Chief Economics Advisor to President George W. Bush, Robert Gnaizdo, former Director of Greenlining Institute, Raghuram Rajan, former Chief Economist of the International Monetary Fund, Bill Ackman, hedge fund manager, Allan Sloan, Senior Editor of *Fortune Magazine*, Jerome Fons, former Managing Director of Moody's Rating Agency, and numerous others. The documentary also includes interviews with various academicians including Nouriel Roubini (New York University), Samuel Hayes (Harvard), Andrew Lo (Massachusetts Institute of Technology), Kenneth Rogoff (Harvard), Frank Partnoy (University of California, San Diego), and Martin Feldstein (Harvard).

Even though *Inside Job* is presented as a documentary based on actual events, the movie presents particular points of view—as do all documentaries. Roger Ebert (2010) characterized it as "an angry, well-argued documentary." An interesting topic for discussion at the end of the movie is whether or not students believe it presents an objective assessment of the causes and effects of the financial crisis.

Inside Job lends itself to several approaches in the classroom. The run time of the movie is 109 minutes. It could be shown in a single class session if a large block of time is normally scheduled for the class or during a special evening class outside of class time. Alternatively, since the documentary is presented in five distinct parts, any or all of which can be presented, it can easily be shown in several consecutive shorter classes with discussion following each part.

Appendix 1 presents a summary of each of the five parts of *Inside Job* and suggested discussion questions.

I have found that *Inside Job* is an excellent way to provide students with background regarding the causes of the financial crisis that helps enrich their understanding of the events dramatized in *Too Big to Fail*, the second movie shown on the global financial crisis. The two movies provide different but complementary perspectives on the financial crisis.

Too Big to Fail

The 2011 HBO movie *Too Big to Fail*, directed by Academy Award-winning director Curtis Hanson, is based on Andrew Ross Sorkin's (2009) multiple award-winning book of the same title. Focusing on the decisions and actions of U.S. Secretary of the Treasury Henry Paulson, it chronicles the events surrounding Lehman Brothers' bankruptcy, the acquisition of Merrill Lynch by Bank of America, the bailout of AIG (the largest government bailout of a private company in U.S. history), negotiations leading to the Emergency Economic Stabilization Act of 2008 creating the $700 billion Troubled Asset Relief Program (TARP), and the U.S. Government's direct capital injections into the largest banks. The movie ends with an epilogue pointing out that in 2010 ten financial institutions held 77% of all U.S. banking assets.

Although based on the actual events as described in Sorkin's book, this movie is a dramatization with William Hurt portraying U.S. Treasury Secretary Henry Paulson, Billy Crudup as Timothy Geitner, President of the Federal Reserve Bank of New York, Paul Giamatti as Ben Bernanke, Chairman of the Federal Reserve System, James Woods as Dick Fuld, CEO of Lehman Brothers, Matthew Modine as John Thain, CEO of Merrill Lynch, Bill Pullman as Jamie Dimon, CEO of JPMorgan Chase, Tony Shalhoub as John Mack, CEO of Morgan Stanley, and Edward Asner as Warren Buffett, CEO of Berkshire Hathaway. Although no doubt using some dramatic license, this movie brings to life the events in August, September and October 2008 that almost led to a collapse of our financial system.

A memorable scene in the movie is when Henry Paulson receives a telephone call from Jeffrey Immedlt, CEO of General Electric (GE), who informs him that:

> You've got to know what's going on around here. We're having trouble funding our day to day operations. Our financial division is infecting

> the rest of our business. This thing is spreading way past Wall Street. I get that no one wants to touch mortgages, but we're making planes and engines, light bulbs—we're a healthy company. If we can't finance our day to day operations, business in American is going to be shutting down. (DVD chapter 6)

Paulson realizes how significantly the disruption in the flow of credit has expanded the crisis beyond Wall Street to the entire U.S. economy.

The run time of *Too Big to Fail* is 98 minutes. As with Inside Job, it could be shown in a single session or in several class periods depending on the amount of time used for class discussion. If the movie is shown in two parts, a good place to stop is about 48 minutes from the beginning of the movie, after Lehman Brother's board of directors votes to approve the company's bankruptcy. A summary of the movie and a set of suggested discussion questions is presented in Appendix 2.

Too Big to Fail keeps students on the edge their seats until the end when there is silence in the classroom. It has a sobering effect on students. Most of the students who take this upper-level undergraduate elective course aspire to or have already obtained jobs on Wall Street. Hopefully, the movie along with *Inside Job* provides an opportunity for them to reflect on role of the finance industry and their future role within it.

BENEFITS AND LIMITATIONS

Movies such as *Inside Job* and *Too Big to Fail* can be used to bring financial and economic topics alive in ways that textbooks and lectures cannot. Movies help instructors make abstract concepts more compelling and real to students.

It is challenging to include the human dimensions of our disciplines. It is ultimately men and women who practice finance, people who are motivated by egos, desire for career success, lust, money, job security, excitement, competition, greed, and power. I have found that undergraduate students are better able to relate to the dramatized characters in a movie than they are to the "real" executives in a written case or article or described by me in class.

As with cases, movies help students understand the organizational context within which financial decisions are made. Movies also add the emotions of real life to complex decision-making situations. This is certainly shown in the drama surrounding the attempts of U.S. Treasury Secretary Henry Paulson to find private sector solutions for Lehman Brothers in the movie *Too Big to Fail*.

The use of these movies in the classroom is not without limitations. The length of each movie exceeds 90 minutes, the length of typical two-day-a-week university classes. In my Cases in Corporate Finance course, which normally meets on Mondays and Wednesdays at 8:35-10:00 a.m., I ask students to arrive at 8:00 a.m.

on the days the movies are shown so that they can be viewed in their entirety. Discussion takes place at the end of class and at the beginning of the following class meeting. This means that more than one class session is devoted to the each movie and discussion.

As described by Dyl (1991), I consider these movies to be "live cases" and quite appropriate for my case course in finance and an excellent use of class time. However, other instructors will not have the "luxury" of expanding an 85-minute class into two hours. It would be even more challenging for others, who teach shorter three-day-a-week classes.

Time in the classroom is a limited resource and various trade-offs are inevitable in course design. Instructors must carefully plan class time to achieve their course objectives and maximize their students' learning experience. The broadly defined goal of my Cases in Corporate Finance course, an upper-level undergraduate elective, is to further students' understanding of applied corporate finance. By the very nature of the course, I have wide latitude in choosing the topics that are covered. I believe that one of the topics, the global financial crisis, is significant enough to justify several class sessions.

An alternative to showing one or both of the movies during normal class periods would be to show them in the evening outside of class time. Another alternative would be to show selected movie clips (excerpts). Movie clips are shorter in duration and usually only focus on one or two pertinent topics. Their short duration provides greater opportunity for subsequent class discussion and topic development. The benefits and limitations of this approach to using movies in the classroom are discussed by Kester et al. (2012).

It is likely that some students have previously watched one or both of the movies. However, it may have been several years since they saw them. The feedback I have received from these students is that watching the movies again was a valuable experience. Because of their course work in economics and finance during the intervening time, they report that their viewing experience was much more meaningful and informed the second time around. They had a better understanding of the context and subject matter.

STUDENT EVALUATION

To evaluate the students' perceptions of *Inside Job* and *Too Big to Fail*, I ask them to complete a questionnaire similar to the ones used by Belden (1992), Nofsinger (1995), and Kester (2013). The survey is anonymous. In the questionnaire, students are asked to indicate their level of agreement with five closed-end statements using a five-point scale ranging from 1 for strongly disagree to 5 for strongly agree. I administered the questionnaire to 47 students who took Cases in Corporate Finance during the Winter 2015, Winter 2016, and Winter 2017 terms.

The students generally agreed with the statement that "class time spent watching the documentary *Inside Job* was well spent" (rating of 4.34). They had a similar positive view of *Too Big to Fail* (rating of 4.49). Of course, the students' perception of "time well spent" may be different than that of the instructor who is primarily concerned with learning outcomes. Several students commented that movies provide a nice change of pace in an otherwise intense course.

They disagreed with the statement that "there was too much overlap between *Inside Job* and *Too Big to Fail"* (rating of 2.21), which suggests that both movies were viewed as worthwhile by the students. Since the questionnaire used to survey the students was limited in scope, it did not reveal what students saw as the differences between the two movies that underlies this result. Obviously, *Inside Job*, is a documentary that is broader in scope than *Too Big to Fail*, which is a dramatization that focuses primarily on the events surrounding the Lehman Brothers' bankruptcy and its aftermath.

The students strongly agreed that "movies such as *Inside Job* and *Too Big to Fail* help bring financial issues and events in to a real world setting" (rating of 4.68). Perhaps not too surprisingly, they disagreed with the statement that "Hollywood movies are not an effective use of class time" (rating of 1.94), a result is similar to the rating of 1.79 reported for the same question by Kester (2013) in a questionnaire regarding the movie *Barbarians at the Gate.*

CONCLUDING COMMENTS

Each time we enter a classroom, we face the question of how to make the day's topic meaningful and relevant for our students. I have found movies to be an effective way to provide students a frame of reference in which to ground learning and complement traditional teaching methods. Movies can help make abstract concepts more compelling and real.

While movies are not a substitute for traditional pedagogical tools, they can provide instructors a way to recreate situations or dilemmas similar to ones that students may face in the future. In short, when used thoughtfully and selectively, movies can stimulate and enhance the learning environment. I encourage other instructors to try this approach and can easily recommend *Inside Job* and *Too Big to Fail* to bring the global financial crisis alive in the classroom.

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Appendix 1: *Inside Job*: Summary and Suggested Discussion Questions

Part I: How We Got Here - 19 minutes

Summary: The long period of regulation following the Great Depression was following by deregulation that began in the 1980s, including the Graham-Leach-Biley Act of 1999 that overturned the 1935 Glass-Steagall Act's separation of commercial and investment banks and the Commodity Futures Modernization Act of 2000 that prevented regulation of derivatives. Investment banks that were formerly privately-owned partnerships became publicly-owned corporations. Mortgage loans also became securitized and bundled into collateralized debt obligations (CDOs) that were sold by investment banks to investors. Because mortgage lenders no longer had to bear the risk of loan default, this gave rise to predatory lending, including subprime loans.

1. How did deregulation of the financial industry lead to the global financial crisis?
2. In the 1980s and 1990s, investment banks that were previously private partnerships went public providing them with large amounts of shareholder money. How might this transition to becoming publicly traded corporations have affected attitudes risk within the investment banks?
3. Why did securitization of mortgage loans lead to the increase in mortgage loans, increase in housing prices, and predatory subprime lending?

Part II: The Bubble (2001-2007)—26 minutes

Summary: Because of the easy availability of mortgage loans, including subprime mortgages, housing prices skyrocketed. Lehman Brothers became the largest underwriter of subprime CDOs. As the result of relaxed standards by the Securities Exchange Commission, the financial leverage of investment banks increased dramatically. At the same time, there was growth in the sale of unregulated credit default swaps (CDSs) that "insured" CDOs against default. AIG, the world's largest insurance company, was the largest issuer of CDSs. CDSs were purchased by speculators as well as investment banks. Goldman Sachs and other investment banks bet against CDO's while at the same time selling them to their clients as high quality investments—often rated as AAA by Moody's, Standard & Poor, and Fitch.

1. How did the rating agencies (Moody's, Standard & Poor, and Fitch)

contribute to the housing price bubble and financial crisis?
2. Did investment banks have an obligation to disclose their "adverse interest" in the CDOs they were selling to investors?
3. How did bonuses paid to traders and executives based on short-term profits encourage bankers to take risks?

Part III: The Crisis—20 minutes

Summary: By 2008, housing prices fell, home foreclosures increased dramatically, lenders could no longer sell their loans to investment banks, and the markets for CDOs collapsed. Investment banks were left holding billions of dollars in loans, CDOs, and real estate they could not sell. In March 2008, Bear Stearns ran out of cash and was acquired by JPMorgan Chase backed by $30 billion in emergency guarantees from the Federal Reserve. In September, Fannie Mae and Freddie Mac were taken over by the government, Lehman Brothers went bankrupt, Merrill Lynch was acquired by Bank of America, AIG was bailed out by the government, and Henry Paulson and Ben Bernanke asked Congress for $700 billion to bail out the banks and get credit flowing again. In October, TARP was signed into law by President Bush. By December, foreclosures reached unprecedented levels, General Motors and Chrysler faced bankruptcy, and the financial crisis and recession expanded globally.

1. How did the fall in housing prices cause the credit crisis faced by the financial system?
2. What should be the government's role in preventing the failure of financial institutions?
3. How could the financial crisis have been prevented?

Part IV: Accountability—16 minutes

Summary: The executives of the troubled banks, including Lehman Brothers, Merrill Lynch, and AIG "walked away with their fortunes intact." The boards of directors, that are often hand-picked by company executives, paid out large bonuses after government bailouts. The banks are now larger and resistant to industry reform. Some prominent academic economists who serve on boards of banks and serve as consultants for sizeable fees have conflicts of interests that are not disclosed in published reports and articles.

1. Just before the acquisition by Bank of America in 2008, insolvent Merrill

Lynch's board of directors paid out $3.6 billion in bonuses. What is your reaction?

2. Do you think that financial conflicts of interest should be disclosed in reports and published articles by academic economists?

Part V: Where We Are Now—12 minutes

Summary: As the financial sector has grown, U.S. manufacturing has declined, jobs have been sent overseas, education costs have increased, and income inequality has risen. The financial reforms of the Obama administration have been weak and not addressed compensation, which has become more strictly regulated in Europe. Individuals who helped build the financial sector—Lawrence Summers, Timothy Geitner, Ben Bernanke, Laura Tyson, and others—were selected to be senior policymakers in the Obama administration. No senior bank executives have been prosecuted for securities or accounting fraud.

1. What is your reaction to the following conclusion at the end of the documentary?

   "For decades, the American financial system was stable and safe. But then something happened. The financial industry turned its back on society, corrupted our political system, and plunged the world economy into crisis." (DVD scene 16)

2. Do you think that *Inside Job* presents an objective assessment of the causes and effects of the global financial crisis?

Appendix 2: *Too Big to Fail*: Summary and Suggested Discussion Questions

Summary: The movie begins with excerpts from various news broadcasts and presidential speeches before and during the financial crisis. Following the government bailout of Bear Stearns, various solutions in the private sector are sought for Lehman Brothers, including its sale to Bank of America that instead decides to purchase troubled Merrill Lunch. Another possibility is the sale of Lehman to Barclays. U.S. Treasury Secretary Henry Paulson organizes a meeting of the largest banks' CEO's who reluctantly agree to purchase Lehman's toxic real estate assets with the remainder to be sold to Barclays. However, British regulators refuse to approve a purchase. Lehman declares bankruptcy. Lehman's counterparty risk affects the entire financial system, the stock market falls, and Paulson receives a telephone from the CEO of General Electric who tells him that GE is having difficulty financing daily operations.

Paulson has also learned that insurance giant AIG is running out of cash and, if allowed to fail, the results would be catastrophic for the financial system. The government bails out AIG. However credit markets remain frozen. New York Federal Reserve President Timothy Geitner tries to arrange mergers between the large troubled investment banks and commercial banks, but without success. Ultimately, Warren Buffet makes a $5 billion investment in Goldman Sachs and Mitsubishi Financial Group invests $9 billion in Morgan Stanley. Paulson and Federal Reserve System Chairman Ben Bernanke decide to lobby Congress for $700 billion to get credit flowing again. After two votes, Congress approves TARP. Paulson concludes that the process of buying the banks' toxic assets will be too slow and decides that direct capital injection is the best option. In another meeting with bank CEOs, Paulson informs them that they will be receiving mandatory capital injections that should be used to make loans. The money comes with few restrictions.

1. Do you agree with U.S. Treasury Secretary Henry Paulson's decision not to bail out Lehman Brothers?
2. Why would the collapse and default of AIG have been catastrophic for the financial industry and global economy?
3. There is a scene in *Too Big to Fail* in which Henry Paulson received a telephone call from the CEO of General Electric (GE), who informed him that GE, a healthy company, was having trouble funding its day to day operations. What are the implications for the economy if the flow of credit did not begin flowing again?
4. What do you think of the strategy of forcing the large banks to accept direct capital investments from the U.S. Government? Should there have been restrictions on how the funds were used?

5. Because of mergers in the midst of the crisis (Wells Fargo and Wachovia, Merrill Lynch and Bank of America, etc.), banks have become even larger. Have banks become too big?
6. Do you think that *Too Big to Fail* presents an objective portrayal of the events of August, September and October 2008?

Cash Flow Statements for Commercial Credit Analysis: UCA vs. FASB 95

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The most commonly discussed cash flow tool in financial management textbooks, financial statement analysis texts, and commercial banking texts is the FASB 95 Statement of Cash Flows. Another cash flow concept that is sometimes mentioned is that of free cash flow. Still another, less well known cash flow technique is the Uniform Credit Analysis (UCA) Cash Flow Statement. The objective of the UCA method is to present a calculation of cash flow that is more useful for commercial credit analysis than either FASB 95 or free cash flow. Using a numeric example, this study compares the FASB 95 and UCA cash flow statements and discusses the benefits of the UCA format, including its role for analyzing the four critical areas of credit analysis. Finally, we recommend that financial management textbooks, financial statement analysis texts, and commercial banking texts expose students to the UCA technique as an alternative to FASB 95 for commercial credit analysis.

Keywords: *Commercial credit analysis, Uniform credit analysis (UCA), FASB 95, cash flow, cash flow statement*

INTRODUCTION

In an earlier article Petty and Rose (2009) derived the accounting statement of cash flows (FASB 95, Indirect format) from the cash flow identity. The "cash flow identity," as termed by Ross, Westerfield, & Jordan (2014), is a distinctly finance-oriented approach to cash flow analysis consistent with the separation of the investment and financing decisions. As such, it emphasizes the cash flow produced by the firm's assets (the left side of the cash flow identity), commonly called "free cash flow." The authors go on to argue that while both cash flow tools

may be used effectively to analyze a firm's financial performance, free cash flow presents more clearly than FASB 95 the cash flow available for distribution to potential investors (debtholders and stockholders). Consistent with this argument, Newman (2004) reports that fixed income investors (debtholders) are much more interested in free cash flow information than earnings per share.

Still another, less well known cash flow tool is the Uniform Credit Analysis (UCA) Cash Flow Statement, which was developed by Wells Fargo Bank, N.A. in the late 1970s. Wells Fargo was a participating bank in the W.T. Grant Co. credit facilities arranged by JPMorgan, N.A., but after W.T. Grant Co. failed in 1975, Wells Fargo reassessed its approach to credit analysis, leading to the development of the UCA cash flow format. The UCA format was subsequently adopted by Robert Morris Associates (RMA) in 1982. (For more information on, and a brief history of, RMA and its link to UCA, see the appendix to this paper.) The objective of the UCA technique is to present a calculation of cash flow that is more useful for commercial credit analysis than either FASB 95 or free cash flow. Since RMA's adoption of the UCA format, numerous analysts have suggested refinements to the UCA method; see, for example, Cassis (2002) and Miller (2006). Additionally, Mulford and Comiskey (2005) have proposed amendments to make the UCA technique appropriate for equity analysis. However, we know of no finance textbook that even mentions the UCA method.

For this paper we reviewed thirteen introductory finance textbooks: Berk, DeMarzo, & Harford (2009); Block and Hirt (2008); Brigham and Houston (2015); Brooks (2013); Gallagher (2012); Gitman (2009); Keown, Martin, & Petty (2014); Lasher (2014); Megginson and Smart (2009); Melicher and Norton (2014); Moyer, McGuigan, & Rao (2015); Parrino, Kidwell, & Bates (2012); Ross et al. (2014). However, we found no mention of the UCA Statement of Cash Flows in any of the books. Nor did we find any reference to UCA in five texts on financial statement analysis: Duke and Fabozzi (2012); Fraser and Ormiston (2016); Fridson and Alvarez (2011); Helfert (2003); Subramanyam and Wild (2009); or in four bank management textbooks: Gup and Kolari (2005); Hempel and Simonson (1999); Koch and MacDonald (2015); Rose and Hudgens (2013). The only books we know of that discuss the UCA Cash Flow Statement are Robert Morris Associates (1982) and Mulford and Comiskey (2005).

The absence of any discussion of the UCA technique in finance textbooks is unfortunate as finance students pursuing a career in business lending, whether through commercial banking or bond underwriting, will likely encounter the UCA format in their professional work. In that regard, at least three financial statement spreadsheet software packages used by commercial banks include a UCA Cash Flow Statement in addition to FASB 95 Direct and Indirect Statements of Cash Flow. The three software packages are Moody's KMV Financial Analyst, Baker-Hill Statement Analyzer, and Web Equity Solutions.

Cash flow statements are designed to examine a firm's liquidity and specifically whether the organization is generating sufficient cash from internal operations to pay interest and amortize debt (Beach, 1985-1986). Recognizing the importance of the cash flow statement to commercial credit analysis, this study 1) compares the FASB 95 Direct and UCA cash flow statements and 2) discusses the benefits of the UCA format. In the next section we compare the focus of the two cash flow statements. Because most firms use the Indirect method to report their FASB 95 Statement of Cash Flows, Petty and Rose (2009) presented the FASB 95 Indirect method for comparison with the cash flow identity. However, the format of the UCA Cash Flow Statement is more closely matched against the FASB 95 Direct method, making the latter format a better technique for comparison with the UCA method. The third section then presents the FASB 95 and UCA cash flow statements in a side-by-side format for a fictional firm, followed by an interpretation of the firm's UCA cash flow data in the fourth section. The fifth section continues the analysis with a discussion of the UCA Cash Flow Statement and the four critical areas of credit analysis for the firm. The last section is a summary and conclusion.

FASB 95 AND UCA CASH FLOW STATEMENTS COMPARED: A DIFFERENCE IN FOCUS

As is well known, the FASB 95 cash flow format, including both the Direct and Indirect methods, separates all the income and balance sheet items with cash flow implications into three groupings—cash flow from operating activities, cash flow from investing activities, and cash flow from financing activities. The net effect of the cash flows from these three groupings is a net increase/decrease in the cash (including cash equivalents) account over the study period. But the breakdown of the FASB 95 cash flow components is largely *static* in nature as it focuses more on the composition of the three groupings and their total net effect on the firm's cash position rather than on the dynamics of the firm's cash flow through the several groupings to the cash account.

By contrast, the UCA cash flow method is more *dynamic* in focus. As explained by Mulford and Comiskey (2005),

> The UCA format cash flow statement begins with collections resulting from sales made and services provided. From that opening amount labeled Cash from Sales, disbursements are deducted based on their importance to operations and priority of cash flow claim. As each disbursement is subtracted from cash collected, a subtotal is calculated that communicates whether cash collections were sufficient to cover that particular disbursement. (p. 14).

The UCA cash flow format is presented in Table 1. For comparison, the FASB 95 format is also shown in a side-by-side arrangement, along with a numbering of the compositional accounts (but not the summary accounts) in both formats. As shown, all the numbered accounts in the FASB 95 format are also listed in the UCA format albeit in a different—in some cases quite different—order. For example, Interest Expense (account 16) is moved from an operating activity in the FASB 95 format to a cash financing cost in the UCA format. Likewise, Current Portion of Long Term Debt (account 21) is moved from financing activities in the FASB 95 format to debt amortization in the UCA format. And Dividends or Owners Withdrawals (account 26) is moved from financing activities in the FASB 95 format to cash financing costs in the UCA format, considerably higher in the listing of cash disbursements.

The different ordering of the accounts in the UCA format more accurately reflects the sequence of additions to/drains from cash generated by operations. To explain, cash from sales in the UCA format less cash production costs generates what is commonly termed Cash from Trading, from which is subtracted cash operating costs to give Cash After Operations. That account is followed by a listing of other income statement and balance sheet events that add to/drain from the cash flow generated from operations, including income taxes paid and other income (expense), financing costs, debt amortization, and capital and other investment expenditures. The effects of these latter events are captured in a continuing sequence of summary cash accounts, namely, Net Cash After Operations, Cash After Financing Costs, and Cash After Debt Amortization, eventually resulting in any Financing Surplus (Requirement).

(Note that some of the terminology for the UCA summary accounts may seem strange to readers more familiar with FASB 95 wording. For example, Cash from Trading may be thought of as "gross cash from operations," and Net Cash After Operations may more effectively be termed "net cash after operations, other income and expenses, and taxes." However, the UCA terminology shown in Table 1 is used consistently in the few books that reference the UCA Cash Flow Statement as well as in the UCA format presented in the three financial statement spreadsheet software packages mentioned above.)

With a Financing Surplus no external or internal financing is needed, leading to an increase in the firm's Cash & Equivalents account on the balance sheet. On the other hand, with a Financing Requirement the UCA format shows the external financing (and by implication any internal financing, as seen in a change in the firm's cash account) to cover the deficiency in cash from operations. Importantly, this sequence of summary cash accounts lends itself more readily than FASB 95 to exploring the four critical areas of credit analysis. Such analysis, in turn, provides the necessary information for forecasting the firm's future debt financing needs and its ability to service any such debt.

Table 1.

	FASB 95 (Direct) Format		UCA Format
	(1) Net Sales		(1) Net Sales
	(2) Change in Current Receivables		(2) Change in Receivables
	Cash Received from Customers		Cash from Sales
	(3) Cost of Goods Sold		(3) Cost of Good Sold
	(4) Selling, General and Administrative Expenses		(6) Change in Inventory
	(5) Other Operating Expenses		(7) Change in Accounts Payable
	(6) Change in Inventories		Cash Production Costs
	(7) Change in Accounts Payable		**CASH FROM TRADING**
	(8) Change in Prepaid Expenses		
	(9) Change in Accrued Expenses		(4) Selling, General and Administrative Expenses
*	(10) Change in Other Current Assets/Liabilities		(5) Other Operating Expenses
	Cash Paid to Supplier/Employers		(8) Change in Prepaid Expenses
			(9) Change in Accrued Expenses
	(11) Other Income (Expense)		(10) Change in Other Current Assets/Liabilities
	(12) Change in Other Liabilities		Cash Operating Costs
	(13) Income Tax Expense		**CASH AFTER OPERATIONS**
	(14) Change in Deferred Income Taxes		
	(15) Change in Income Taxes Payable		(11) Other Income (Expense)
	(16) Interest Expense		(12) Change in Other Liabilities
	(17) Change in Interest Payable		(13) Income Tax Expense
#	(18) Change in Intangibles/Other Assets		(14) Change in Deferred Income Taxes
	Other Changes in Operating Cash		(15) Change in Income Taxes Payable
	Net Cash Provided by Operating Activities		Taxes Paid & Other Income (Expense)
			NET CASH AFTER OPERATIONS
	(19) Capital Expenditures		
	(20) Change in Long Term Investments	*	(26) Dividends or Owner Withdrawals
	Net Cash Used for Investing Activities		(27) Change in Dividends Payable
			(16) Interest Expense
	(21) Current Portion of Long Term Debt		(17) Change in Interest Payable
	(22) Change in Short Term Debt		Cash Financing Costs
	(23) Change in Long Term Debt		**CASH AFTER FINANCING COSTS**
	(24) Change in Contributed Capital		
	(25) Other Changes in Retained Earnings		(21) Current Portion of Long Term Debt
	(26) Dividends or Owners Withdrawals		**CASH AFTER DEBT AMORTIZATION**
	(27) Change in Dividends Payable		
	Net Cash Provided by Financing Activities		(19) Capital Expenditures
			(20) Change in Long Term Investments
	(28) **Change in Cash & Equivalents**		(18) Change in Intangibles/Other Assets
			Cash Used for Plant & Equipment
		#	(29) Related Parties—Change in Loans from Owners
			FINANCING SURPLUS (REQUIREMENT)
			(22) Change in Short Term Debt
			(23) Change in Long Term Debt
			(24) Change in Contributed Capital
			(25) Other Changes in Retained Earnings
			TOTAL EXTERNAL FINANCING
			(28) **CHANGE IN CASH & EQUIVALENTS**

* Changes in Loans to Owners will be reflected in (26) UCA Dividends and Owners Withdrawals.

\# Changes in Loans from Owners will be reflected in (29) UCA Related Parties—Changes in Loans from Owners.

The four critical areas of credit analysis are as follows:

1. What is the Cash Source(s) for Servicing Existing Interest-Bearing Debt?

If all the summary cash accounts (Cash After Operations, etc.) through Cash After Debt Amortization are positive, then the firm generated sufficient cash flow after taxes paid and other income (expense) to pay interest and reduce long-term debt as scheduled. This is the preferred and primary source of debt service.

If Cash After Financing Costs is positive but Cash After Debt Amortization is negative, the firm generated sufficient cash flow to cover all of its cash operating expenses, taxes paid, and other expenses including interest expense and other financing costs, but it failed to generate enough cash flow to repay long-term debt as scheduled.

If Cash After Debt Amortization is negative, leading to a Financing Requirement equal to or greater (due to long-term investments, intangibles, and other assets) than the negative Cash After Debt Amortization, then the shortfall in cash flow to cover debt service will be satisfied with either an increase in Total External Financing or a decrease in Cash & Equivalents. However, a negative Cash After Debt Amortization followed by a Financing Surplus suggests an inflow of cash from a related party(ies) such as other companies and/or owners.

In general, a company will first use its existing cash balances to cover a debt service cash flow shortfall. If such balances are insufficient, it will then look to related parties such as other companies and/or owners. The next likely source is additional short-term debt followed by new long-term debt. It should be noted that some borrowers may find it easier to draw down on a short-term line of credit rather than use existing cash balances or seek loans from related parties. Only in the direst circumstances will a firm resort to the sale of fixed assets to produce the necessary cash to pay interest expense and repay long-term debt as scheduled.

2. Is There a Requirement for Additional Financing?

If there is a Financing Surplus, the firm generated sufficient operating cash to meet all cash outlays related to its business including debt service and long-term investments. The amount of any such Financing Surplus will flow to the firm's Cash & Equivalents.

By contrast, a Financing Requirement represents a shortfall of operating cash flow after taxes paid and other income (expense) to meet all of the firm's business cash outlays. In such a case, if the firm does not wish to reduce its Cash & Equivalents, it will need to raise cash from a combination of external sources in the form of short-term debt, long-term debt, and/or capital injections to meet the deficit.

3. What is the Cause(s) of the External Financing Requirement?

If Cash After Operations is negative, this signals a financing cause that resulted from an increase in an asset(s) associated with the firm's operations and/or an increase in an operating expense(s), albeit without sufficient operating cash flow to fund the asset and/or cover the added operating expense(s).

If Net Cash After Operations is also negative, there was insufficient cash flow after taxes paid and other income (expense) to fund the asset(s) and/or the operating expense(s) identified above. By contrast, if Net Cash After Operations was positive, the cash shortage after operations was covered by other income after taxes were paid.

If the firm continues to record negative Cash After Financing Costs, it did not have sufficient cash to cover financing costs (dividends and interest paid in cash). Moreover, a negative Cash After Financing Costs will necessarily lead to a negative Cash After Debt Amortization from paying the current portion of long-term debt.

Finally, if the Financing Requirement is more negative than Cash After Debt Amortization, there is also a long-term financing cause(s) e.g., fixed asset spending. By contrast, a Financing Surplus may indicate there is no financing cause or there is an offsetting cash inflow provided by a related party(ies) such as other companies and/or owners.

With each negative summary cash account the task then is to use a combination of performance ratios and the UCA cash flow data to identify the event(s) that is/are driving the negative summary account.

4. What is the Cash Source(s) to Meet the Financing Requirement?

If Total External Financing exceeds the Financing Requirement, the change in Cash & Equivalents will be positive resulting in an increase in the firm's Cash & Equivalents.

However, if Total External Financing is less than the Financing Requirement, the firm was not able to cover its cash flow deficit with a combination of additional short-term debt, long-term debt, and/or capital injections. This indicates that the firm was compelled to use some or all of its existing cash balances to meet its cash needs for the period, resulting in a negative Change in Cash & Equivalents.

FASB 95 AND UCA CASH FLOW STATEMENTS COMPARED: AN ILLUSTRATION

To illustrate the differences in cash flow treatment between FASB 95 and UCA, consider Tables 2-5, which present financial statements for fictional firm Gulf States Distributors, Inc. (GSDI) for 2013 (balance sheet only), 2014, and

2015. Year-end balance sheets are presented in Table 2; income statements, in Table 3; and a comparison of the FASB 95 Direct and UCA cash flow statements for 2014 and 2015, in Tables 4 and 5, respectively. Focusing on Tables 4 and 5, the left side of each table shows the three groupings of FASB 95 cash flows as explained earlier. Taken together, the net effect of the three groupings is an increase in the cash account of $1,080 during 2014 and a decrease of $6,475 during 2015, matching the changes in the cash account on the firm's balance sheets for the two years.

Table 2.

GULF STATES DISTRIBUTORS, INC.

As of December 31

($ in thousands)

	2013	2014	2015
Assets			
Cash & Marketable Securities	21,000	22,080	15,605
Accounts Receivable (net)	42,000	39,000	51,000
Inventory	71,657	94,373	117,459
Prepaid Expenses	1,200	1,100	2,000
Total Current Assets	135,857	156,553	186,064
Gross Fixed Assets	650,000	666,380	724,980
Less: Accumulated Depreciation	(364,000)	(394,000)	(434,000)
Net Plant and Equipment	286,000	272,380	290,980
Other Assets	0	18	54
Total Assets	421,857	428,951	477,098
Liabilities			
Accounts Payable	48,000	54,500	52,400
Accrued Wages/Salaries	0	2,500	3,125
Notes Payable	9,500	6,000	34,000
Current Maturities of Long-Term Debt	20,657	21,822	23,053
Federal Income Taxes Payable	0	4,760	4,960
Total Current Liabilities	78,157	89,582	117,538
Long-Term Debt	171,500	150,843	143,022
Total Liabilities	249,657	240,425	260,560

Table 2. (*Continued*).

GULF STATES DISTRIBUTORS, INC.

As of December 31

($ in thousands)

	2013	2014	2015
Stockholders' Equity			
Common Stock & Paid-In Capital	22,200	22,200	34,500
Retained Earnings	150,000	166,326	182,038
Total Stockholders' Equity	172,200	188,526	216,538
Total Liabilities and Stockholders' Equity	421,857	428,951	477,098

Table 3.

GULF STATES DISTRIBUTORS, INC.

As of December 31

($ in thousands)

	2014		2015	
Sales Revenue	600,000		650,000	
Cost of Goods Sold	(460,000)		(487,500)	
Gross Income		140,000		162,500
Operating Expenses				
Selling, General and Administrative	(18,480)		(24,650)	
Lease Expense	(6,000)		(6,500)	
Officer Salaries	(2,520)		(4,350)	
Depreciation	(30,000)		(40,000)	
Total Operating Expenses		(57,000)		(75,500)
Earnings Before Interest and Taxes (EBIT)		83,000		87,000
Interest Income		3,000		2,000
Interest Expense		(8,082)		(7,346)
Earnings Before Taxes (EBT)		77,918		81,654
Income Taxes		(26,492)		(27,762)
Net Income		51,426		53,892
Net Income		51,426		53,892
Dividends Paid		(35,100)		(38,180)
Addition to Earnings		16,326		15,712

Table 3. (*Continued*).

GULF STATES DISTRIBUTORS, INC.

As of December 31

($ in thousands)

	2014	2015
Beginning Retained Earnings	150,000	166,326
Addition to Retained Earnings	16,326	15,712
Ending Retained Earnings	166,326	182,038

The middle section of Tables 4 and 5 breaks out the array of cash flow items shown in the FASB 95 statement and presents them under the equivalent UCA items ordered to match the UCA statement sequence on the right side of each table. As shown, all of the FASB 95 statement items are captured in the UCA statement items albeit in a different order, as noted earlier in the comparison of the FASB 95 and UCA cash flow statements in Table 1.

Looking first at the UCA statement for 2014 on the right side of Table 4, Cash from Trading (cash from sales minus cash production costs) of $126,784 is reduced to Cash after Operations of $102,384, owing primarily to selling, general and administrative expenses along with other operating expenses. That amount is further reduced primarily due to income tax expense to Net Cash After Operations of $83,652. Next, cash financing costs (dividends and interest expense) drain another $43,182, leaving Cash After Financing Costs of $40,470. GSDI's current portion of long term debt pulls out another $20,657, leaving Cash After Debt Amortization of $19,813. Finally, cash used for plant & investment of $16,398 further reduces the firm's cash flow from operations; however, the firm is still left with a Financing Surplus of $3,415. With no Financing Requirement GSDI is thus able to reduce its external financing, primarily short-term debt (notes payable), by $2,335 and still add $1,080 to its cash account.

Turning to the UCA statement for 2015 on the right side of Table 5, Cash from Trading of $125,314 is reduced to Cash after Operations of $89,539, owing primarily to selling, general and administrative expenses along with other operating expenses. That amount is further reduced to Net Cash After Operations of $63,977 due primarily to income tax expense. Next, cash financing costs (dividends and interest expense) drain another $45,526, leaving Cash After Financing Costs of $18,451. But after paying the current portion of long term debt the firm is left with negative Cash After Debt Amortization of -$3,371. Finally, cash used for plant & investment of $58,636 further reduces the firm's cash flow from operations, leaving a Financing Requirement of -$62,007. The Financing Requirement is then met with new external financing, including short- and long-term debt and

Table 4. 2014 FASB 95 (Direct) and UCA Cash Flow Statements Compared.

Gulf States Distributors, Inc. 2014 FASB 95 (Direct) Cash Flow ($ in thousands)		2014 UCA Cash Flow Components										Gulf States Distributors, Inc. 2014 UCA Cash Flow ($ in thousands)	
		(1) Cash from Sales	(2) Cash Production Costs	(3) Cash Operating Costs	(4) Taxes Paid & Other Inc. (Exp.)	(5) Cash Financing Costs	(6) Current Portion of LT Debt	(7) Cash Used for Plant & Investment	(8) Total External Financing	(9) Change in Cash & Equivalents			
Net Sales	600,000	600,000										Net Sales	600,000
Change in Current Receivables	3,000	3,000										Change in Accounts Receivable	3,000
Cash Received from Customers	603,000										(1)	Cash from Sales	603,000
Cost of Goods Sold	(460,000)		(460,000)									Cost of Goods Sold	(460,000)
Selling, General and Administrative Expenses	(18,480)			(18,480)								Change in Inventories	(22,716)
Other Operating Expenses	(8,520)			(8,520)								Change in Accounts Payable	6,500
Change in Inventories	(22,716)		(22,716)								(2)	Cash Production Costs	(476,216)
Change in Accounts Payable	6,500		6,500									**CASH FROM TRADING**	**126,784**
Change in Prepaids	100			100									
Change in Accrued Expenses	2,500			2,500								Selling, General and Administrative Expense	(18,480)
Change in Other Current Assets/Liabilities	0			0								Other Operating Expenses	(8,520)
Cash Paid to Suppliers/Employees	(500,616)											Change in Prepaid Expenses	100
												Change in Accrued Expenses	2,500
Other Income (Expense)	3,000				3,000							Change in Other Current Assets/Liabilities	0
Change in Other Liabilities	0				0						(3)	Cash Operating Costs	(24,400)
Income Tax Expense	(26,492)				(26,492)							**CASH AFTER OPERATIONS**	**102,384**
Change in Deferred Income Taxes	0				0								
Change in Income Taxes Payable	4,760				4,760							Other Income (Expense)	3,000
Interest Expense	(8,082)					(8,082)						Change in Other Liabilities	0
Change in Interest Payable	0					0						Income Tax Expense	(26,492)
Change in Intangibles/Other Assets	(18)							(18)				Change in Deferred Taxes	0
Other Changes in Operating Cash	(26,832)											Change in Income Taxes Payable	4,760
											(4)	Taxes Paid & Other Income (Expense)	(18,732)
Net Cash Provided by Operating Activities	**75,552**											**NET CASH AFTER OPERATIONS**	**83,652**
Capital Expenditures	(16,380)							(16,380)				Dividends or Owners Withdrawals	(35,100)
Change in Long Term Investments	0							0				Change in Dividends Payable	0
												Interest Expense	(8,082)
Net Cash Used for Investing Activities	**(16,380)**											Change in Interest Payable	0
											(5)	Cash Financing Costs	(43,182)
Current Portion of Long Term Debt	(20,657)						(20,657)					**CASH AFTER FINANCING COSTS**	**40,470**
Change in Short Term Debt	(3,500)								(3,500)				
Change in Long Term Debt	1,165								1,165		(6)	Current Portion of Long Term Debt	(20,657)
Change in Contributed Capital	0								0			**CASH AFTER DEBT AMORTIZATION**	**19,813**
Other Changes in Retained Earnings	0								0				
Dividends or Owners Withdrawals	(35,100)					(35,100)						Capital Expenditures	(16,380)
Change in Dividends Payable	0					0						Change in Long Term Investments	0
												Change in Intangibles/Other Assets	(18)
Net Cash Provided by Financing Activities	**(58,092)**										(7)	Cash Used for Plant & Investment	(16,398)
												Related Parties-Change in Loans from Owners	0
Change in Cash & Equivalents	**1,080**											**FINANCING SURPLUS (REQUIREMENT)**	**3,415**
												Change in Short Term Debt	(3,500)
												Change in Long Term Debt	1,165
												Change in Contributed Capital	0
												Other Changes in Retained Earnings	0
											(8)	**TOTAL EXTERNAL FINANCING**	**(2,335)**
		603,000	**(476,216)**	**(24,400)**	**(18,732)**	**(43,182)**	**(20,657)**	**(16,398)**	**(2,335)**	**1,080**	(9)	**CHANGE IN CASH & EQUIVALENTS**	**1,080**

Table 5. 2015 FASB 95 (Direct) and UCA Cash Flow Statements Compared.

Gulf States Distributors, Inc. 2015 FASB 95 (Direct) Cash Flow ($ in thousands)		2015 UCA Cash Flow Components										Gulf States Distributors, Inc. 2015 UCA Cash Flow ($ in thousands)	
		(1) Cash from Sales	(2) Cash Production Costs	(3) Cash Operating Costs	(4) Taxes Paid & Other Inc. (Exp.)	(5) Cash Financing Costs	(6) Current Portion of LT Debt	(7) Cash Used for Plant & Investment	(8) Total External Financing	(9) Change in Cash & Equivalents			
Net Sales	650,000	650,000										Net Sales	650,000
Change in Current Receivables	(12,000)	(12,000)										Change in Accounts Receivable	(12,000)
Cash Received from Customers	638,000										(1)	Cash from Sales	638,000
Cost of Goods Sold	(487,500)		(487,500)									Cost of Goods Sold	(487,500)
Selling, General and Administrative Expenses	(24,650)			(24,650)								Change in Inventories	(23,086)
Other Operating Expenses	(10,850)			(10,850)								Change in Accounts Payable	(2,100)
Change in Inventories	(23,086)		(23,086)								(2)	Cash Production Costs	(512,686)
Change in Accounts Payable	(2,100)		(2,100)									**CASH FROM TRADING**	**125,314**
Change in Prepaids	(900)			(900)									
Change in Accrued Expenses	625			625								Selling, General and Administrative Expense	(24,650)
Change in Other Current Assets/Liabilities	0			0								Other Operating Expenses	(10,850)
Cash Paid to Suppliers/Employees	(548,461)											Change in Prepaid Expenses	(900)
												Change in Accrued Expenses	625
Other Income (Expense)	2,000				2,000							Change in Other Current Assets/Liabilities	0
Change in Other Liabilities	0				0						(3)	Cash Operating Costs	(35,775)
Income Tax Expense	(27,762)				(27,762)							**CASH AFTER OPERATIONS**	**89,539**
Change in Deferred Income Taxes	0				0								
Change in Income Taxes Payable	200				200							Other Income (Expense)	2,000
Interest Expense	(7,346)					(7,346)						Change in Other Liabilities	0
Change in Interest Payable	0					0						Income Tax Expense	(27,762)
Change in Intangibles/Other Assets	(36)							(36)				Change in Deferred Taxes	0
Other Changes in Operating Cash	(32,944)											Change in Income Taxes Payable	200
											(4)	Taxes Paid & Other Income (Expense)	(25,562)
Net Cash Provided by Operating Activities	**56,595**											**NET CASH AFTER OPERATIONS**	**63,977**
Capital Expenditures	(58,600)							(58,600)				Dividends or Owners Withdrawals	(38,180)
Change in Long Term Investments	0							0				Change in Dividends Payable	0
												Interest Expense	(7,346)
Net Cash Used for Investing Activities	**(58,600)**											Change in Interest Payable	0
											(5)	Cash Financing Costs	(45,526)
Current Portion of Long Term Debt	(21,822)						(21,822)					**CASH AFTER FINANCING COSTS**	**18,451**
Change in Short Term Debt	28,000								28,000				
Change in Long Term Debt	15,232								15,232		(6)	Current Portion of Long Term Debt	(21,822)
Change in Contributed Capital	12,300								12,300			**CASH AFTER DEBT AMORTIZATION**	**(3,371)**
Other Changes in Retained Earnings	0								0				
Dividends or Owners Withdrawals	(38,180)					(38,180)						Capital Expenditures	(58,600)
Change in Dividends Payable	0					0						Change in Long Term Investments	0
												Change in Intangibles/Other Assets	(36)
Net Cash Provided by Financing Activities	**(4,470)**										(7)	Cash Used for Plant & Investment	(58,636)
												Related Parties-Change in Loans from Owners	0
Change in Cash & Equivalents	**(6,475)**											**FINANCING SURPLUS (REQUIREMENT)**	**(62,007)**
												Change in Short Term Debt	28,000
												Change in Long Term Debt	15,232
												Change in Contributed Capital	12,300
												Other Changes in Retained Earnings	0
											(8)	**TOTAL EXTERNAL FINANCING**	55,532
		638,000	**(512,686)**	**(35,775)**	**(25,562)**	**(45,526)**	**(21,822)**	**(58,636)**	**55,532**	**(6,475)**	(9)	**CHANGE IN CASH & EQUIVALENTS**	**(6,475)**

equity investment, totaling $55,532 plus a drain of the Cash & Equivalents account (internal financing) in the amount of $6,475.

ANALYSIS OF THE DATA PRESENTED IN GSDI'S UCA CASH FLOW STATEMENTS

Data presented in the 2014 and 2015 UCA cash flow statements in Tables 4 and 5 allow for several observations. First, as noted earlier, all of the 2014 and 2015 FASB 95 cash flow items are also found in the 2014 and 2015 UCA cash flow statements, respectively, albeit in a different order. Second, Net Cash After Operations is positive and sufficient to cover both the 2014 and 2015 cash financing costs but not the firm's debt amortization requirement for 2015.

At this point the two UCA cash flow sequences diverge as GSDI's 2014 Cash After Debt Amortization of $19,813 is sufficient to fund the firm's capital expenditures, leaving a Financing Surplus for 2014 and no need for additional financing. In fact, the firm reduces its total debt, particularly its short-term debt, in 2014 and still shows an increase in its Cash & Equivalents account. Thus, a credit analyst would likely be supportive of any reasonable borrowing request by GSDI going forward.

By contrast, with a negative Cash After Debt Amortization of -$3,371 in 2015 GSDI evidences a level of cash from operations that is not only insufficient to cover its required debt amortization for the year but also inadequate to fund its 2015 capital expenditures. As a result, the firm must draw on both external and internal funding to cover the short-fall in cash from operations. Most importantly, the firm increases it short-term debt (notes payable) by $28,000, equivalent to slightly over half of its new external financing. Thus, 1) without generating sufficient cash from operations to service fully its existing debt, let alone cover its capital expenditures, coupled with 2) relying heavily on new short-term debt to meet its financing requirement, GSDI is in a weak financial position to request additional external financing going forward from 2015.

But this conclusion would surface from using either the UCA or FASB 95 cash flow methods. So how does the UCA cash flow tool enhance credit analysis over the FASB 95 method? To address this question we focus on the four critical areas of credit analysis.

THE UCA CASH FLOW STATEMENT AND THE FOUR CRITICAL AREAS OF CREDIT ANALYSIS

1. <u>What is the Cash Source(s) for Servicing Existing Interest-Bearing Debt?</u>

   GSDI likely used either existing cash balances or additional short-term debt—or some combination of the two—to cover the $3,371 cash shortfall

necessary to meet its interest-bearing debt service. As the 2015 UCA Cash Flow Statement illustrates, cash flow from internal operations fell short by $3,371 from fully covering interest-bearing debt service, i.e., interest expense and scheduled long-term debt repayment.

By contrast, FASB 95 suggests that GSDI was able to meet its entire 2015 interest-bearing debt service from operating cash flow. That is, Net Cash Provided by Operating Activities of $56,595 less scheduled long-term debt repayment of $21,822 give a positive $34,773 rather than a negative $3,371 per the UCA Cash Flow Statement.

Since the same data are presented in FASB 95, albeit in a different order, the comparable figure to the UCA Cash After Debt Amortization of −$3,371 can be calculated as Net Cash Provided by Operating Activities of $56,595, less scheduled long-term debt repayment of $21,822 and Dividends or Owners Withdrawals of $38,180, plus change in intangibles/other assets of $36, giving a cash flow deficit of −$3,371. This figure is identical to the UCA Cash After Debt Amortization of −$3,371, but it requires the analyst to calculate the deficit by pulling out the figures from FASB 95 whereas the UCA format makes the cash deficit after financing costs immediately clear.

2. Is There a Requirement for Additional Financing?

As shown in GSDI's UCA Cash Flow Statement, the firm's Financing Requirement for 2015 was $62,007. By contrast, the FASB 95 statement suggests a 2015 financing requirement of only $2,005, calculated as the firm's Net Cash Provided by Operating Activities of $56,595 less Net Cash Used for Investing Activities of $58,600. The reason for such a disparity is that unlike the FASB 95 financing requirement calculation, which typically only recognizes financing costs in the form of interest expense, the UCA financing requirement also recognizes financing costs in the form of $38,180 of dividends or owners' withdrawals and $21,822 of current portion of long-term debt, which together sum to $60,002. Adding the FASB 95 financing requirement of $2,005 gives the total UCA financing requirement of $62,007.

3. What is the Cause(s) of the External Financing Requirement?

Returning to GSDI's UCA Cash Flow Statement for 2015, we see that GSDI's dominant 2015 operating borrowing cause (increase in an asset associated with the firm's operations) was the $23,086 increase in inventory that was amplified by a $2,100 decrease in accounts payable, followed by a $12,000 increase in accounts receivable. The firm's capital expenditures of $58,600 were the second, and long-term, 2015 borrowing cause for the firm.

Of course, the same dollar increases in inventory and accounts receivable are seen in the FASB 95 cash flow statement. However, because the increases in inventory and accounts receivable are embedded in a bundle of balance sheet

and income statement items in Net Cash Provided by Operating Activities, it is difficult to identify the increases in inventory and accounts receivable as operating borrowing causes. Further, since the standard FASB 95 statement does not provide the equivalent of Cash After Debt Amortization, there is no mechanism to direct the analyst to look for an operating borrowing cause as there is in the UCA statement. Therefore, a FASB 95 user, in noting a positive cash amount in Net Cash Provided by Operating Activities, may conclude that no operating borrowing cause existed.

4. What is the Cash Source(s) to Meet the Financing Requirement?

GSDI arranged $55,532 of external financing to help meet the $62,007 financing requirement, including $28,000 of additional short-term debt, $15,232 of new long-term debt, and $12,300 of capital contributions. Since total external financing of $55,532 fell short of the financing requirement by $6,475, the firm used $6,475 of existing cash balances to close the gap.

Again, by contrast, FASB 95 indicates total external financing (net cash provided by financing activities) of only $4,470, clearly a significant under-calculation of the actual amount of external financing received by the firm in 2015.

In sum, a lender using only the FASB 95 statement for analysis of the firm's 2015 cash flow would likely have 1) failed to identify the source of cash to meet 2015 interest-bearing debt service, 2) failed to identify correctly the 2015 financing requirement, 3) failed to identify correctly the 2015 borrowing causes, and 4) failed to identify the cash sources used to meet the 2015 financing requirement.

SUMMARY AND CONCLUSION

Cash flow statements are designed primarily to determine whether a firm is generating sufficient cash from internal operations to pay interest and amortize debt. The most commonly addressed cash flow statement in financial management textbooks, financial statement analysis texts, and commercial banking texts is the FASB 95 Statement of Cash Flows, which may be presented in either a Direct or Indirect format. Another cash flow concept that is sometimes mentioned is that of free cash flow. Still another, less well known cash flow technique is the Uniform Credit Analysis (UCA) Cash Flow Statement, the objective of which is to present a calculation of cash flow that is more useful for commercial credit analysis than either FASB 95 or free cash flow.

Recognizing the importance of the cash flow statement for analysis of business loans, this study 1) compares the FASB 95 Direct Statement of Cash Flows and the UCA Cash Flow Statement and 2) discusses the benefits of the UCA cash flow format. After discussing the difference in focus between the two methods, the

study compares the two formats in a side-by-side presentation using a numeric illustration for a fictional firm for two years. Finally, the data presented in the example firm's UCA Cash Flow Statements are analyzed, including a comparison of the two cash flow formats in addressing the four critical areas of credit analysis.

Finance students pursuing a career in business lending, whether through commercial banking or bond underwriting, will likely encounter the UCA cash flow format in their professional work. Thus, we recommend that financial management textbooks introduce the UCA Cash Flow Statement, perhaps in an appendix to a chapter on financial statement analysis. And certainly, books on financial statement analysis, as well as commercial banking texts, should expose students to the UCA format. Perhaps most useful would be a comparison of the FASB 95 Direct format and the UCA format to help students appreciate the difference in focus across the two formats and the benefit of the UCA method for commercial credit analysis.

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Appendix

Robert Morris Associates, Wells Fargo Bank, N.A., and the UCA Cash Flow Statement

SOME HISTORICAL BACKGROUND

Robert Morris Associates (RMA) was founded in 1914 to promote the exchange of credit information among commercial banks. (The organization was named for Robert Morris, who helped to finance the American Revolution and was one of Pennsylvania's original pair of U.S. senators. For a short biography of Robert Morris, see "Robert Morris (financier)" and references cited on Wikipedia (2015). A full-length biography of Morris is presented in Rappleye (2010).)

Two years after its founding RMA adopted a Code of Ethics, now known as Principles for the Exchange of Credit Information. Nearly a century later, in recognition of the growing number of nonbank commercial lending organizations and the broad array of risks facing financial institutions, RMA changed its name in 2000 to The Risk Management Association, maintaining the "RMA" moniker. The purpose of the new name was to expand the organization's commitment to sound risk principles in all areas of financial institution operations. Currently, RMA has approximately 2,500 institutional members, including commercial banks and nonbank financial institutions, and over 18,000 risk management professionals in North America, Europe, Asia, and the Pacific. RMA is perhaps best known for its annual publication, *RMA Statement Studies*, which presents financial statement information on Standard Industrial Classification (SIC) industry groups for use in commercial credit analysis.

In the late 1970s Wells Fargo Bank, N.A. formalized its financial statement analysis and credit policy with two documents, "Uniform Credit Analysis Banks/ Wells Fargo" and "Uniform Credit Analysis." These documents were copyrighted in 1981 and presented a comprehensive approach to credit assessment, the centerpiece of which was Wells Fargo's UCA Statement of Cash Flow.

Subsequently, in 1982, Robert Morris Associates [prior to changing its name in 2000] adopted a variation of Wells Fargo's UCA cash flow format for its member institutions to use for commercial credit analysis. Several years later, in 1987, the Financial Accounting Standards Board adopted its own cash flow statement which was formalized in FASB Statement 95, allowing firms to use either of two formats—the Direct or Indirect Statement of Cash Flows. In fact, most firms have chosen to use the Indirect format as it is simpler than the Direct format. RMA, however, preferred the UCA Cash Flow format over the FASB 95 formats and

continues to promote the UCA Cash Flow Statement through published articles, course materials and seminars. It should be noted, however, that the format of the UCA Cash Flow Statement has been modified over time by RMA, individual financial institutions, and consulting firms. For example, Rex Beach & Associates currently offers consulting workshops on its own UCA format through "Shockproof! Training" webcasts to banking organizations and bank regulators.

Why Do Some Employees Choose Only the Minimum Retirement Contribution? Evidence from a Medium-size, Private University

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This paper examines why some individuals contributed only to the minimum required to their retirement fund compared to those who contributed more than the minimum required to get the matching contribution from their organization. Based on a survey data from a midsize private university faculty and staff, the results show that the minimum contribution group are younger, less knowledgeable about retirement, less likely to discuss retirement, less likely to check and rebalance their accounts, receive less income, have less TIAA years, and are less financially comfortable. In addition, they meet with retirement professionals less often than the other group, and calculate their retirement costs less often than the other group. To help those who contributes minimum, it is suggested more retirement education, discussion, and training opportunities be offered to all Americans, especially the younger generation and lower income groups.

Keywords: *minimum retirement contribution, retirement knowledge, low income.*

1. INTRODUCTION

Although the US economy has recovered from the recent economic crises including the housing market trouble in late 2006 to 2008, the collapse of financial institutions, and stock market crash in 2008, the crisis affected all long-term financial planning areas. Especially hard hit were the financial areas of retirement, bringing more concerns not only to the current retirees who experienced heavy losses from their retirement sources, but also the younger generations as they are planning for their future old-age support. With uncertain Social Security benefits, reduced employer sponsored plan benefits, and traditional defined benefit plans

being replaced by defined contribution plans which leaves more risk on the employees' hands, future retirees will have to rely more on personal savings for retirement. However, research by Employee Benefit Research Institute (EBRI) shows that Americans do not have adequate retirement savings.[1] The findings from EBRI's survey indicate that more than half of workers and a little less than half of retirees have a problem with their high level of debt. The retirement confidence level was increased in 2014 from the record lows between 2009 and 2013. However, those who said they have "virtually no savings and investment" increased from 28 percent in 2013 to 36 percent in 2014.

This study focuses on those who participate in the employer sponsored retirement plan and investigates why they only contribute to the minimum required. While there have been numerous studies that dealt with retirement related issues, there is no study that has addressed the issue stated previously as we know of. Moreover, relatively fewer studies have been done on the effects of retirement benefit policy on retirement preparation. Poterba et al (1998) analyzed retirement saving patterns with 401(k) plans and predicted the plans would be a main retirement income source for future retirees. Madrian and Shea (2001) examined employees' savings behavior before and after their company's retirement policy change. The company they studied changed the 401(k) plan from affirmatively elect participation to automatic enrollment. They reported the change made much higher 401(k) enrollment by employees. The change especially encouraged the lowest participation groups including minority groups, the young, and low income groups to participate. However, many employees just chose the suggested default contribution rate and the default conservative fund allocation which led to lower total savings and lower returns. They recommended employers find ways to increase the default rates and provide more aggressive investment options.

Over a decade later, similar savings behavior was found in our data. The institution used for this study offers an employer matching contribution if employees save three percent or more of their salary. The data showed almost half of the participants contributed the minimum required percent. We examine whether there are differences between individuals who contributed the minimum required to their retirement fund and those who contributed beyond the minimum required related to their retirement knowledge, attitudes toward retirement, and retirement management. The study answered the questions, at least in part, who contributed the minimum rate required and how they can be helped out of their 'comfort zone' to be better prepared for retirement years.

The remainder of the paper was organized as follows. Section 2 described the sample and presents the descriptive statistics. Section 3 discusses the results and their implications.

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[1] EBRI's 2014 Retirement Confidence Survey, retrieved on April 16, 2015 from http://www.ebri.org/publications/ib/index.cfm?fa=ibDisp&content_id=5362.

2. DATA

This study used survey responses from a major Pacific Coast Christian university in the United States.[2] Survey questions were developed to include demographic information such as age, gender, household size, and ethnicity. Other questions are geared to answer variables such as income, retirement knowledge data such as understanding of TIAA web, fee structure, asset allocation, and self-evaluation of retirement knowledge, retirement attitude data, how comfortable they are financially, and finally, retirement management data including retirement contribution amount, the frequency of seminar attendance, retirement check and rebalance, and retirement discussion. Emails were sent out to participate in the survey by clicking the link provided in the email. The data was collected over a period of two weeks starting from April 29, 2009 to May 14, 2009. Since we conducted the survey via email using Survey Monkey, some of the faculty and staff members may not had a chance to participate in the survey especially if they did not use their email over the survey periods. We received 324 responses including 166 faculty (41.4 percent of full-time faculty) and 198 staff (30.3 percent of full-time staff).

Table 1 shows selected descriptive statistics. Of the 324 individuals who responded to the survey, 58 percent were female and 42 percent were male. The average age was 46.3 years and the average household size was 2.74 where 16% are single family. Race was coded as white or non-white and 76.9 percent were white. Income was the pre-tax bimonthly income since the participants received it bimonthly. More than half (55%) said they understood their retirement account information at the TIAA website, however, only 35% answered they understood the fee structure of the account. The question of how one is knowledgeable about retirement was measured with a 5-point Likert-type scale, ranging from "very knowledgeable (5-point)" to "not at all (1-point)." Only 27% answered as being very knowledgeable or knowledgeable, but 42% said they are 'a little' or 'not' knowledgeable.

For the retirement attitude, participants were asked how comfortable they were financially regarding retirement using a 4-point Likert-type scale, ranging from "very comfortable (4-point)" to "not at all (1-point)." Over 60% of the respondents (62%) felt either very comfortable or somewhat comfortable but 12% did not feel comfortable at all. The number showed more people felt comfortable than a national survey by Employee Benefit Research Institute (EBRI) in 2009 which found 55 % and 22 % respectively. Several variables are used to measure the retirement management issues. The contribution amount in employer sponsored plans was measured by the percentage of their bimonthly salary on a before-tax basis. On

[2] The university studied is a Western Association of Schools and Colleges accredited institution located in the Pacific Coast in the United States. In 2009, the university has about 8,500 graduate and undergraduate students, 401 full-time faculty, and 653 permanent staff.

Table 1. Descriptive Characteristics of Variables.

Characteristics	N	Mean (S.D.)	%	Median	Min.	Max.
Gender						
Male	135		41.7			
Female	189		58.3			
Understand account Web						
Yes	176		54.7			
No	100		31.1			
Not use	46		14.3			
Understand account fee						
Yes	103		34.8			
No	193		65.2			
Understand asset allocation						
Yes	188		63.1			
No	110		36.9			
Met professional						
Yes	112		35.7			
No	202		64.3			
Attended seminars						
Yes	97		30.5			
No	221		69.5			
Comfortable financially	323	2.61 (.82)		2	1	4
Contribution %[1]	306	5.89 (5.85)		3		50
Total contribution[2]	324	8.84 (9.60)		3	0	60
Rebalance allocation[3]	320	1.58 (.816)		1	1	6
Discuss retirement[4]	309	2.70 (1.65)		2	1	8
Age	324	46.32 (13.04)		49.50	22	72
Check account[5]	324	3.23 (1.38)		3	1	8
Knowledgeable[6]	322	2.78 (1.06)		3	1	5
Household size	321	2.74 (1.34)		2.00	1	8

Table 1. (*Continued*).

Characteristics	N	Mean (S.D.)	%	Median	Min.	Max.
Income[7]	324	3,008 (1,690)		2,500	750	8,000

[1]Contribution measured as percentage of semi-monthly income before tax basis.
[2]Employer sponsored contribution and other personal contribution as percentage of semi-monthly income before tax basis.
[3] Rebalance retirement allocation over last 10 years measured with an 8-point Likert-type scale, ranging from "never (1-point)" to "more than once a week (8-point)."
[4] Discuss retirement with spouse (or significant other).
[5] Check retirement account over last 10 years.
[6] Retirement knowledge variable measured with 5-point Likert-type scale, ranging from very (1-point) to no knowledge (5-point)
[7] Income measured as semi-monthly before tax basis.

average, respondents saved 5.9% of their salary in the TIAA-CREF account and 3.5% more for their retirement beyond the TIAA-CRFF account. As shown in Figure 1, almost half of the employer sponsored plan participants contributed the minimum rate required to receive the matching contribution by the employer.

TIAA offers education opportunities through electronic newsletters, seminars on campus, and at local offices. In addition, participants can meet a TIAA professional to receive assistance concerning retirement financial preparation. Only 30% 'ever attended' the financial education seminars offered by the TIAA-CREF at campus and around 35% 'ever met' the investment professionals by the TIAA-CREF. In general, the participants did not often check nor did they rebalance the account. Over the last 10 years, 10 % of respondents 'never' checked their account and only 14 % 'checked' their account once a month or more often. To the question how often do you rebalance your retirement allocation, 57 % said 'never' and 34% answered at least once a year. Participants did not discuss their retirement often. Among those who were married and had a spouse, 18 % of them

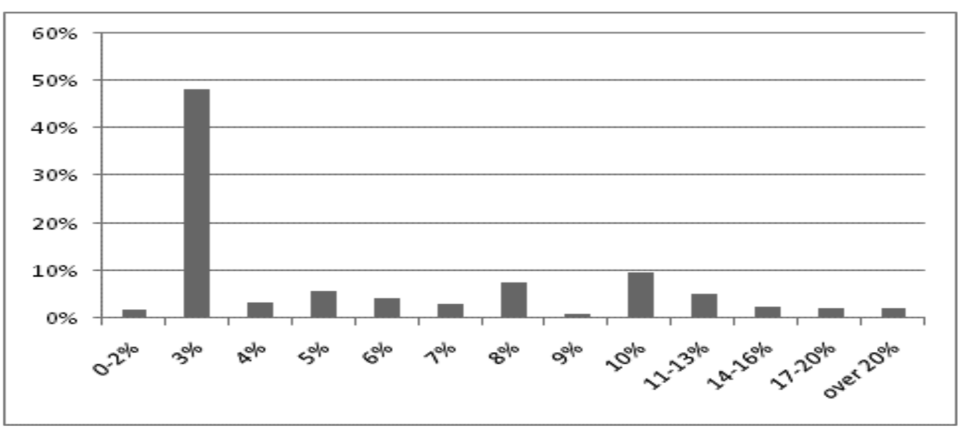

Figure 1. Contribution amount as the percentage of salary.

never discussed the issue. Those who did not discuss their retirement were not young couples.

Around half (46%) of them were over 40 years old. More people wanted to work longer. The participants, on average, planned to retire at age 64 which was similar to the survey by Employee Benefit Research Institute (EBRI) in 2009, but longer than a previous research in 1992 by Boseman and Smith (1992) where boomers wanted to retire at age 59. In addition, to the question when will you retire, five percent of the participants did not want to retire at all and fourteen percent answered they did not know. The employer sponsored account was the largest retirement income source (45%) for the participants with a house (18%), other (16%), personal saving (9%), IRA (7%), and Social Security (5%) following. Only 31% of the participants calculated their cost of living for after they retire compared to 44% of the respondents in EBRI (2009) survey.

3 RESULTS

Data was compared between those who contribute three percent and those with more than three percent contribution to find any similarities and differences related to the retirement variables. First, we separated the dataset between those with required minimum contribution to receive the employer' sponsored matching benefit (Policy group) and those with more than the minimum (Beyond group). Since we used the contribution amounts, we dropped those who did not contribute nor use the retirement matching benefit. The final data ended up 276 observations. Based on the data characteristics, we used chi-squares, Mann-Whitney, or t-test statistics by SPSS. Chi-square statistics were used to investigate whether the minimum contribution group and the other group differ on whether they are faculty or not, understand the TIAA-CREF web account information or not, meet professional to discuss their retirement or not, attend retirement seminars or not, want to work after retirement or not, and calculate retirement costs or not.

Table 2 shows the results. The feature as to whether they are faculty or not was significantly different between the Policy group and Beyond group ($\chi^2 = 30.03$, $p < .001$). The two groups were not different by gender structure. Understanding of their retirement account, the account fee structure, and asset allocation were not significantly different between the two groups. While Policy group and Beyond group were significantly different on whether they meet professionally to discuss their retirement or not ($\chi^2 = 20.89$, $p < .001$), the two groups were not different on whether they attended retirement seminars or not. The Policy group and Beyond group were significantly different on whether they calculated retirement costs or not, and on whether they would work after retirement or not ($\chi^2 = 10.44$, $p < .01$, and $\chi^2 = 4.49$, $p < .05$, respectively). For the variables clearly ordinal or parametric assumptions markedly violated, we used a nonparametric statistic, Mann-Whitney, to compare the two groups. The Policy group compared to Beyond group

Table 2. Group comparison.

The Policy group was compared to the Beyond group on the retirement related variables. We conducted the group comparison using chi-squares, Mann-Whitney, or t-test statistics based on the data characteristics.

Variables	N	Policy	Beyond	χ^2	P
Status				30.03	.000***
Faculty	114	35	79		
Staff	162	104	58		
Gender				.121	.728
Male	118	58	60		
Female	158	81	77		
Understand account Web				3.64	.162
Yes	159	73	86		
No	83	45	38		
Not use	32	20	12		
Understand account fee				.15	.698
Yes	95	46	49		
No	161	82	79		
Understand asset allocation				3.81	.051
Yes	169	78	91		
No	90	53	37		
Met professional				20.89	.000***
Yes	107	35	72		
No	160	98	62		
Attended seminars				.27	.606
Yes	93	45	48		
No	178	92	86		
Work after retire				4.49	.034*
Yes	160	70	90		
No	77	45	32		
Calculated living costs				10.44	.001**
Yes	90	33	57		
No	179	103	76		

Table 2. Group comparison.

	N	Policy (MR)	Beyond (MR)	M-W	P	
Comfortable financially	275	138 (126.9)	137 (149.2)	7921	.012*	
Rebalance allocation	272	138 (120.0)	134 (153.1)	7024	.000***	
Discuss retirement	262	133 (118.1)	129 (145.4)	6790	.003**	
TIAA year	272	137 (113.8)	135 (159.6)	6132	.000***	
	N	**Mean (SD)**		***t***	***df***	***p***
Age				−6.04	274	.000***
Policy	139	42.25 (12.70)				
Beyond	137	50.91 (11.06)				
Check account				−.48	274	.626
Policy	139	3.29 (1.39)				
Beyond	137	3.37 (1.24)				
Knowledgeable				−4.59	272	.000***
Policy	138	2.57 (1.05)				
Beyond	136	3.13 (.96)				
Household size				1.75	271	.082
Policy	137	2.91 (1.42)				
Beyond	136	2.63 (1.22)				
Income				−2.71	274	.007**
Policy	139	2,769.78 (1,662.42)				
Beyond	137	3,299.27 (1,584.87)				
Retirement age				−1.02	220	.308
Policy	114	63.96 (4.70)				
Beyond	108	64.57 (4.15)				
Other Ret. Resources				−1.22	180	.224
Policy	77	3.08 (1.34)				
Beyond	105	3.32 (1.35)				

*P< .05, **P < .01, *** P < .001

showed less comfortable financially. The 138 individuals in the Policy group had significantly lower mean ranks (126.9) than the 137 respondents in the Beyond group (149.2) on financial comfortableness, U = 7921, p = .012. There was a significant difference in the mean ranks of Policy group (120.0) and Beyond group

Table 3. Coefficient estimates of a model explaining the minimum required contribution behavior.

Logistic regression was used and dependent variables are whether contribute just the minimum required or not (Yes = 1, No = 0). Exponentiated B (the odds ratio) values were reported in parentheses.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Gender	.637 (1.89)		.246 (1.28)	.409 (1.51)	.531 (1.70)
Faculty	−1.112 (.33)**	−1.349 (.26)***			−1.092 (.34)**
Age	−.036 (.97)*		−.047 (.95)**		−.027 (.97)*
Income[1]		.024 (1.02)		−.171 (.84)	
RetDiscussion		−.129 (.88)		−.097 (.91)	
Meet Professional	−.803 (.45)**		−.861 (.42)**		−.781 (.46)**
CostCalculation		−.400 (.67)	.315 (1.37)		
RetAccountCheck		.114 (1.12)	.134 (1.14)		.212 (1.24)
Rebalance	−.183 (.83)			−.346 (.71)	−.279 (.76)
Knowledge	−.423 (.66)*		−.531 (.59)**		−.474 (.62)**
FinanciallyComfortable		−.279 (.76)		−.330 (.72)*	
TIAA year	.022 (1.02)			−.043 (.96)*	
Intercept	3.47 (31.97)***	1.31 (3.70)*	3.36 (28.77)***	2.46 (11.73)***	2.87 (17.67)***
χ^2	65.42***	38.09***	50.54***	27.21***	65.67***

*P< .05, **P < .01, *** P < .001

[1]Income level from 1= $750, 2= 1,500, … , 8 = 7,500.

(153.1) on rebalancing their account allocation, U = 7024, p = .000. Those who contribute the minimum rate showed less comfortable financially and rebalanced their account less often than those who contribute more than the minimum rate. The Policy group had significantly less years of TIAA and showed less often discussion compared to the Beyond group. The group comparison results of the t-test showed the Policy group was younger (p < .001), had less retirement knowledge (p <

.001), and less income ($p < .01$) than the Beyond group. The Policy group checked less often than Beyond group, but it was not significant statistically. The household size for policy group was larger than the size for Beyond group, but not significant statistically. The Beyond group had more 'other financial resources' for retirement and wanted to work longer than Policy group, but neither of them were significant statistically.

Logistic regression was performed to identify the determinants related to the minimum contribution behavior. To check the validity of the model with the assumptions of logistic regression, the tolerance and the variance inflation factors through the linear regression (Leech, Barrett, and Morgan, 2007) were evaluated. The independent variables in each model were selected to minimize the multicollinearity. The results of the regression analysis were presented in Table 3. The models showed they significantly predicted whether just minimum required contribution or more when all the predictor variables were considered together in each model (For example, $\chi^2 = 65.42$, df $=7$, N$=258$, $p<.001$ for Model 1).

Each model contains coefficient estimates, exponentiated B, and significant level. Among demographic variables, gender and income level were not significant. However, faculty and age were significant consistently. For example, in Model 5, the coefficient of faculty status was negative and the odds ratio was 0.34 indicating that the odds of contributing minimum required is 66 percent lower than the odds for staff. This suggests that faculty is more inclined to choose the minimum required contribution that staff. For unit increase in age, the odds of contributing just the minimum required decrease by 3 percent. While the TIAA year was not significant, it became significant and negative if we dropped faculty and age, which was probably due to the fact that TIAA year was significantly related to age. Among retirement management data, the frequency of retirement account check, that of account rebalance and discussion were not significant. However, the results showed that more meetings with retirement professionals were associated with lower odds of minimum contribution. More retirement knowledge was significantly less likely to contribute minimum required than was less knowledge.

4. CONCLUSIONS AND SUGGESTION FOR FURTHER STUDY

To our knowledge, no previous studies compared those who contribute the required minimum with those who contribute more than the minimum. The two-group comparison showed they were quite different in many aspects. While the two groups were not different by gender structure, the Policy group were younger, less knowledgeable, less financially comfortable, discuss and rebalance their account less, had shorter TIAA years, less income and fewer faculty and more staff than the Beyond group. More people in the Beyond group met with retirement professionals, calculated their retirement costs, and wanted to work

after retirement than those in the Policy group. However, understanding of their retirement account, the account fee structure, asset allocation, and attending retirement seminars were not significantly different between the two groups. The Beyond group had more financial resources available for retirement and wanted to work longer than the Policy group but neither of them were significant statistically.

Logistic regression showed that gender, income level, the frequency of retirement account check, that of account rebalance and discussion were not significant. However, faculty status and older age decreased the odds of contributing just minimum required. More often meetings with retirement professionals and more retirement knowledge showed significantly less likely to contribute to the minimum required.

The gap between actual and adequate preparation, which has widened year by year, suggests that more retirement education, discussion, and training opportunities should be offered to American workers, especially the younger generation and lower income groups. This could include starting personal finance courses in high school, requiring one or two personal finance classes as a part of undergraduate curriculum, and promoting promotion of local/regional/national programs about retirement planning. The institutions, which design the employee retirement benefits, need to consider developing methods to increase their employees' savings to the employer sponsored retirement account, especially those younger and lower income group. Mandating quarterly reviews of retirement funds by organizations with their employees would be a good start. Although employers may be not responsible for the quality of their employees' life after leaving work, offering ways to increase employees' voluntary saving to their retirement accounts may benefit the institution through employees increased financial comfortableness which may lead to higher productivity.

Our study focuses on a private educational institution. Further research using a data set from a for-profit organization, such as a corporation, or a public university and comparing it to the study is recommended. Investigating why many people contribute only the minimum required in retirement planning with more demographic, socioeconomic, and psychological variables is also recommended. Since people have various financial resources for their retirement such as a house, other types of savings, their future income predictions, and inheritance, the effect of those asset values to the retirement contribution was not examined in the study, which could be worth investigating.

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Using Free Internet Data to Estimate S&P 500 Constituents and Weights

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Most business schools offer finance courses that utilize equity index data. Current and historical data, at the constituent level, are particularly useful for risk and attribution analyses in investment courses and student managed investment fund programs. Index data subscriptions, used by professional money managers, are beyond the budget of many schools. This paper describes how to use free internet data to estimate current and historical constituent data for one of the most commonly-used equity indices: the S&P 500.
Keywords: *equity index data, S&P 500, student managed investment funds, virtual portfolios, pedagogy*

INTRODUCTION

As has become increasingly common at business schools, our finance program includes courses in which students actively manage a real-dollar all-equity portfolio. The portfolio's benchmark is the S&P 500 index. Learning activities and reporting requirements necessitate providing students with the S&P 500 constituents and their weights within the index, their sector classifications, and their holding period returns.

Professional money managers purchase index data subscriptions to obtain real-time and historical constituent data that include the company names, weights, sectors, and returns. When we have investigated these subscriptions for possible purchase for the program, they have been more expensive than our program could afford. As described in this paper, an alternative is to use free internet data to estimate the current and historical data needed.

MOTIVATION

Most students are introduced to the S&P 500 index and its importance in their earliest finance course. For example, Berk, DeMarzo, and Harford (2015) describe

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the S&P 500 index as "a standard benchmark for professional advisors", "the most commonly cited index when evaluating the overall performance of the U.S. stock market", and "the standard portfolio used to represent 'the market' in practice" (p. 376). Upper level investment courses often allow students to manage virtual or real money. If the S&P 500 index is used as a benchmark in these courses, students require up-to-date data for the index's constituents and their weights, industry sector mappings, and returns.

The S&P 500 index maps each constituent to one of ten industry sectors using the Global Industry Classification System (GICS) 2-digit classification (S&P Dow Jones Indices, 2015a). The sectors are Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Telecommunication, and Utilities. One of the ten sectors, Telecommunication, has a market capitalization that is dominated by just two firms, AT&T and Verizon. In practice, the Telecommunication sector can be combined with the Information Technology sector to create a single Technology sector. This is the approach used by State Street Bank and Trust Company, who include the Telecommunication firms in the Technology sector in their partition of the S&P 500 firms to create nine Select Sector SPDR ETFs.

Constituent weights within each Select Sector SPDR ETF are proportional to their weights in the S&P 500 index. As stated on the Select Sector SPDR ETF website (n.d.), the sector ETFs can be used to invest in "the well-known, large cap stocks of the S&P 500, with the ability to over-weight or under-weight particular sectors."

Alternatively, investing in all nine sector ETFs can replicate the S&P 500 index. Replication requires investing in each of the 9 sector ETFs according to that sector's weight in the S&P 500 index. After the close of trading each day, the Select Sector SPDR ETF website updates an estimate of the weight of each of the 9 sector ETFs in the S&P 500 index. Estimated weights are to the nearest 0.01%, and the estimated weights of the 9 ETFs sum to 100%.

For each sector, the Select Sector SPDR website provides downloadable holdings data (the constituent names, tickers, and weights) in Excel and csv file formats. Data are current as of the most recent daily close. Thus, by downloading the data for each sector and using the website estimates of sector weight in the S&P 500 index, one can approximate the current S&P 500 list of constituents and weights.

Students require historical as well as current index data. An example of portfolio analysis that requires historical index data is attribution analysis, which allocates the portfolio's active return between sector-weight decisions and decisions to underweight or overweight stocks within each sector. Extending the notation of Stewart, Piros, and Heisler (2010), we define the portion of the active return that results from decisions to deviate from the benchmark sector weights as the allocation effect (AA_{AE}):

$$AA_{AE} = \sum_j \{(S_{Pj} - S_{Bj}) * (rs_{Bj} - R_B)\} \quad (1)$$

where S_{Pj} is the weight of sector j in the portfolio, S_{Bj} is the weight of sector j in the benchmark, rs_{Bj} is the benchmark's sector j return for the period, and R_B is the total return of the benchmark. Sector weights are as of the beginning of the holding period analyzed.

The selection effect (AA_{SE}) is the return contribution that can be attributed to decisions to deviate from the benchmark's weights of specific securities, including decisions to exclude some benchmark securities entirely or include securities not in the benchmark. The selection effect (AA_{SE}) is:

$$AA_{SE} = \sum_j \{S_{Pj} * (rs_{Pj} - rs_{Bj})\} \quad (2)$$

where rs_{Pj} is the portfolio's sector j return for the period.

Historical data for constituents and sector weights are not available from the Select Sector SPDR website directly but can be estimated using the process described in the following sections.

OVERVIEW OF THE PROCESS FOR ESTIMATING S&P 500 INDEX DATA

The process for obtaining the current data and estimates of the historical data for the S&P 500 index is:

1. Obtain the list of current S&P 500 index constituents, their weights in the index, and the weight of each of the 9 sectors using data from the Select Sector SPDR ETF website: http://www.sectorspdr.com/sectorspdr/sectors .
2. Obtain the holding period returns for the S&P 500 index constituents for the period of interest using data from the finance.yahoo.com website.
3. Use data from the finance.yahoo.com website for the Select Sector SPDR ETFs to backfill price and return data for "missing" observations that result from constituent changes made by S&P Dow Jones Indices during the period of interest.
4. Perform the calculations to estimate the historical data for the S&P 500 index for the period of interest.

Details for each step are provided in the subsequent sections of this paper. We automate the process using SAS, and our code for automating the website downloads is provided in the Appendix. As discussed in the "Extensions" section of this paper, the accuracy of the estimates can be improved by running the above

process after trading hours each night as a batch job to create a permanent database of the daily estimates.

OBTAINING CURRENT S&P 500 HOLDINGS AND WEIGHTS

The first step obtains the current S&P 500 index constituents, weights, and sector classifications from the Select Sector SPDR ETF. This step also can be used as a learning activity to allow students to create their own Excel spreadsheets of the current S&P 500 constituents, a map of each constituent to its sector, and the weight in the index of each constituent and each sector. A discussion of our experience of how using the learning activity improved student outcomes is provided later in the "Assurance of Learning" section of this paper.

Specific instructions for the learning activity are:

1. Go to the Select Sector SPDR ETF website: http://www.sectorspdr.com/sectorspdr/sectors.
2. Obtain data for one of the 9 sectors (the Consumer Discretionary sector ETF, ticker: XLY) provided at: http://www.sectorspdr.com/sectorspdr/sector/xly. The webpage displays the "Estimate Weight of XLY Components in the S&P 500" and the date of the estimate. Obtain the ETF's sector weight in the S&P 500 index.
3. Click on the "Holdings" tab and select the option to "Create a spreadsheet of index components" as an Excel file. The data elements in the downloaded Excel file include the company names, trading symbols, and weight of each company in the ETF.
4. Insert a column that indicates the ETF's sector weight in the S&P 500 index.
5. Repeat the process for the other 8 sector ETFs.
6. Stack the data for the 9 ETFs in a single Excel worksheet.
7. Obtain each constituent's weight in the S&P 500 index, which equals its weight in its ETF multiplied by its ETF's sector weight in the index.
8. Check the sum of the individual constituent weights in the S&P 500 index equals 100%.
9. Check the sum of the sector weights in the S&P 500 index equals 100%.

OBTAINING CONSTITUENT HOLDING PERIOD RETURNS

The next step is to obtain the holding period returns for the S&P 500 index constituents for the period of interest. Historical prices can be obtained from finance.yahoo.com. We use adjusted close prices to reflect adjustments for splits and dividends.

BACKFILLING MISSING PRICES AND RETURNS

Before the final step that calculates historical sector weights and returns, we need to address the issue of survivorship bias in the constituent price and return data. Changes in the constituent list of the S&P 500 index are more frequent that one might expect. Changes occur for various reasons. Recent examples include:

- Replacement of Avon Products Inc. with Hanesbrands Inc., after the close of trading March 20, 2015 (Associated Press, 2015, March 13). Historical prices for Hanesbrands Inc. (ticker: HBI) are available on finance.yahoo.com as of September 6, 2006.
- Replacement of QEP Resources, Inc. with Baxter International Inc.'s spinoff Baxalta Inc., after the close of trading June 30, 2015 (Associated Press, 2015, June 19). Historical prices for Baxalta (ticker: BXLT) are available on finance.yahoo.com as of June 15, 2015.
- On July 2, 2015, Kraft Foods Group (ticker: KRFT) and H.J. Heinz Company merged (Business Wire, 2015, July 2). Kraft Foods Group was a member of the S&P 500 prior to the merger. The merged company, Kraft Heinz Company (ticker: KHC), replaced Kraft Foods Group (ticker: KRFT) in the S&P 500 after the close of trading July 2. Price data for the merged company, Kraft Heinz Company (ticker: KHC), are available as of the first trading day in the S&P 500 on July 6, 2015.

One of the benefits of working with CRSP data is that delisting returns are provided that account for how shareholders of merging companies are affected. These CRSP delisting returns make it easy for academic researchers to control for survivorship bias when examining portfolio strategies. The finance.yahoo.com historical price database provide adjusted close prices, which adjust for dividends and splits, but these do not incorporate delisting returns.

We do not search for S&P 500 index changes in constituents, maintain a time series of changes, or manually calculate delisting returns. Instead, we make the following simplifying assumptions.

1. For the holding period timeframe of interest, we assume the current constituents are the constituents for the entire period.
2. If price data are available for the entire period in the finance.yahoo.com database, we use that data. For example, for Hanesbrands, even if we are estimating the index data prior to its addition to the S&P 500, price data are available back to September 6, 2006.
3. If price data are unavailable for part of the holding period timeframe of interest (e.g., for June 2015 and earlier for spinoff Baxalta and the merged company Kraft Heinz Company), we backfill data for the unavailable dates

using the holding period returns of the applicable Select Sector SPDR ETF. For example, data for the Health Care ETF and Consumer Staples ETF are used to backfill data for Baxalta and Kraft Heinz Company, respectively.

We backfill adjusted close prices using the equation:

$$adjClose_{i,t} = adjClose_{ETF,t} * (adjClose_{i,T} / adjClose_{ETF,T}) \quad (3)$$

where $adjClose_{i,t}$ is the adjusted close price we need to obtain to backfill unavailable data for constituent *i* for date *t*, $adjClose_{ETF,t}$ is the adjusted close price for the constituent's sector ETF for date *t*, and $adjClose_{i,T}$ and $adjClose_{ETF,T}$ are for date *T*, which is the earliest date for which adjusted close prices are available for constituent i in the yahoo.finance.com database. Backfilling is only needed when $t < T$ for constituent i.

ESTIMATING HISTORICAL INDEX DATA

Historical data for the S&P 500 index are estimated as follows.

1. Assume a dollar value for the S&P 500 index portfolio on the "current date" (i.e. the date that the Select Sector SPDR ETF holdings and weights are obtained).
2. Calculate the number of shares for each constituent in this portfolio using finance.yahoo.com adjusted close price data.
3. For the earliest date of interest (date *t*), assume that the constituents and the number of shares of each constituent held in the S&P 500 index portfolio are the same as in the "current date" S&P 500 index portfolio. Use the backfilled adjusted close price dataset for date *t* to calculate the dollars held in each of the constituents on date *t*, the total dollar value of the S&P 500 index portfolio on date *t,* and each constituent's weight on date *t*. Use the dollar value of the S&P 500 index portfolio on the current date and on date *t* to estimate the holding period return of the S&P 500 index.
4. Aggregate constituents by sector to calculate the dollars held in each sector on date *t*. Calculate each sector's weight in the index on date *t* and holding period return.
5. The estimated constituent weights and backfilled adjusted close price dataset can be used to estimate weights and returns for any date within the date *t* and current date time period.

Comparison of Estimates with Actual Weights and Returns

In this section, we report a comparison of the estimates of historical sector weights and S&P 500 total returns with actual data for 8 dates in the prior 12 months. These estimates were generated using the steps described in the previous

sections, including the assumptions for backfilling price and return data for changes in constituents. Data were downloaded from the Select Sector SPDR ETF website and finance.yahoo.com on September 9, 2015. For 2 of the 8 dates, we were able to obtain sector weights from S&P Dow Jones Indices published reports. For August 31, 2015, the data are available in the S&P 500 month-end Factsheet retrieved from the S&P Dow Jones Indices website on September 13, 2015 (S&P Dow Jones Indices, 2015a). We were able to obtain data for December 31, 2014, from an S&P Dow Jones Indices newsletter (S&P Dow Jones Indices, 2015b). For 6 other dates in the prior 12 months, sector weights had been obtained from the Select Sector SPDR ETF website.

Table 1 reports the comparison for the 8 dates. For each date, we report the number of days between the date of estimation and the "current date" (9/9/2015), the estimated sector weight, the actual sector weight, the difference (i.e. estimated weight minus actual weight), and the average (across the 9 sectors) of the absolute value of the difference. The absolute value of the differences between estimated and actual sector weights are remarkably small (less than 20 basis points on average across sectors on any date and never more than 40 basis points for any sector on any date). Given that error is introduced by not replicating changes in constituents, by backfilling price data for replaced constituents, and by not attempting to replicate the periodic reweighting of constituent weights by S&P Dow Jones Indices, it is not surprising that the differences in estimates for more recent dates (e.g., 8/31/2015 and 4/24/2015) are of smaller magnitude than for the earlier dates.

For reference, the "Memo" rows at the bottom of Table 1 report the actual weights on the "current date" (9/9/2015) and repeat the actual weights on the earliest date estimated (8/15/2014). This shows how much greater the magnitude of the differences in sector weights would be if, rather than estimating the sector weights for 8/15/2014, we simply used the current data. The absolute value of the differences between estimated and actual sector weights would have been 92 basis points, with the largest error for the Energy sector weight, with a difference of 3.39%.

We also can compare estimated S&P 500 index total returns for any holding period in the August 15, 2014 to September 9, 2015 period with actual S&P 500 total returns using historical data available at the WSJ website: http://quotes.wsj.com/index/XX/SPXT/historical-prices.

For each of the 8 estimation dates in Table 1, we estimate constituent weights and use the backfilled adjusted close price dataset to calculate the return through the "current date" (9/9/2015). Table 2 reports the results. The actual index returns (using the WSJ website data) for these holding periods range from -7.524% for the portfolio formed on April 24, 2015 (which has a holding period of 138 calendar days), to 1.538% for the portfolio formed on August 15, 2014 (which has a holding period of 390 calendar days). The differences between estimated and actual returns

Table 1. Comparison of Estimated and Actual S&P 500 Sector Weights.

Date	Days prior to 9/9/2015	Cons. Discr.	Cons. Staples	Energy	Financials	Health Care	Indust.	Tech.	Materials	Utilities	Average Abs. Diff.
8/15/2014	390										
Estimate		11.68%	9.19%	10.45%	16.22%	13.58%	10.43%	22.08%	3.44%	2.94%	
Actual		11.94%	9.49%	10.41%	16.07%	13.53%	10.31%	21.74%	3.53%	2.98%	
Difference		20.26%	20.30%	0.04%	0.15%	0.05	0.12%	0.34%	20.09%	20.04%	0.16%
10/3/2014	341										
Estimate		11.59%	9.37%	9.56%	16.63%	14.03%	10.37%	22.15%	3.34%	2.98%	
Actual		11.80%	9.60%	9.50%	16.50%	14.00%	10.20%	22.00%	3.40%	3.00%	
Difference		20.21%	20.23%	0.06%	0.13%	0.03	0.17%	0.15%	20.07%	20.03%	0.12%
12/2/2014	281										
Estimate		11.73%	9.46%	8.38%	16.59%	14.50%	10.59%	22.30%	3.19%	3.08%	
Actual		11.90%	9.90%	8.50%	16.40%	14.50%	10.40%	22.10%	3.20%	3.10%	
Difference		20.17%	20.21%	20.19%	0.19%	0.00	0.19%	0.20%	20.01%	20.02%	0.13%
12/31/2014	252										
Estimate		11.95%	9.59%	8.26%	16.87%	14.19%	10.69%	22.10%	3.18%	3.17%	
Actual		12.13%	9.80%	8.44%	16.65%	14.21%	10.41%	21.94%	3.17%	3.24%	
Difference		20.18%	-0.21%	20.19%	0.22%	20.02	0.28%	0.16%	0.01%	20.07%	0.16%
1/15/2015	237										
Estimate		11.75%	9.98%	7.85%	16.39%	14.80%	10.59%	22.09%	3.19%	3.34%	
Actual		11.94%	10.21%	8.06%	16.15%	14.82%	10.32%	21.91%	3.18%	3.41%	
Difference		20.19%	-0.23%	20.21%	0.24%	20.02	0.27%	0.18%	0.01%	20.07%	0.16%
3/17/2015	176										
Estimate		12.38%	9.47%	7.75%	16.56%	14.97%	10.59%	22.19%	3.17%	2.92%	
Actual		12.50%	9.60%	7.80%	16.40%	15.10%	10.30%	22.10%	3.20%	3.00%	
Difference		20.13%	-0.13%	20.05%	0.16%	20.13	0.29%	0.09%	20.01%	20.08%	0.12%
4/24/2015	138										
Estimate		12.47%	9.37%	8.31%	16.06%	14.94%	10.33%	22.39%	3.19%	2.95%	
Actual		12.70%	9.50%	8.30%	16.00%	14.90%	10.20%	22.20%	3.20%	3.00%	
Difference		20.23%	20.13%	0.01%	0.06%	0.04	0.13%	0.19%	20.01%	20.05%	0.09%
8/31/2015	9										
Estimate		12.90%	9.70%	7.30%	16.60%	15.20%	9.90%	22.40%	2.90%	2.97%	
Actual		12.90%	9.60%	7.80%	16.40%	15.10%	10.30%	22.10%	3.20%	3.00%	
Difference		0.00%	20.03%	20.07%	0.05%	20.04	0.16%	0.00%	0.05%	20.03%	0.05%
Memo: Actural Sector Weights											
8/15/2014	390	11.94%	9.49%	10.41%	16.07%	13.53%	10.31%	21.74%	3.53%	2.98%	
9/9/2015	0	13.04%	9.68%	7.02%	16.50%	15.16%	10.19%	22.54%	2.95%	2.93%	
Difference		21.10%	20.19%	3.39%	0.43%	21.63	0.12%	20.80%	0.58%	0.05%	0.92%

range from -0.181% (for the holding period beginning March 17, 2015) to 0.118% (for the holding period beginning October 3, 2014).

Table 2. Comparison of Estimated and Actual S&P 500 Total Returns.

Estimate Date	Days prior to 9/9/2015	SAS Estimate	Actual	SAS Estimate Minus Actual	Ticker; SPY Estimate	Ticker: SPY Estimate Minus Actual
8/15/2014	390	1.630%	1.538%	0.092%	1.466%	−0.071%
10/3/2014	341	0.728%	0.610%	0.118%	0.583%	−0.027%
12/2/2014	281	−4.459%	−4.518%	0.060%	−4.551%	−0.032%
12/31/2014	252	−4.303%	−4.315%	0.012%	−4.359%	−0.044%
1/15/2015	237	−1.156%	−1.204%	0.047%	−1.225%	−0.022%
3/17/2015	176	−5.636%	−5.455%	0.181%	−5.472%	−0.016%
4/24/2015	138	−7.647%	−7.524%	0.123%	−7.532%	−0.009%
8/21/2015	9	−1.457%	−1.474%	0.017%	−1.407%	−0.066%

For comparison, we also report returns and differences if the SPDR S&P 500 ETF (Ticker: SPY) adjusted close prices from finance.yahoo.com are used to estimate the holding period return. The differences between estimated and actual returns are smaller but not dramatically so, ranging from -0.071% to 0.066% for the 8 dates analyzed.

EXTENSIONS

Rather than rely on estimations of historical index data, an alternative would be to set up a batch program to run after the close each trading day. Actual holdings and weights would be stored in a permanent database. The actual index constituents, sector mappings, and weight data could be extracted as desired for use on future dates. Adjusted close data would be updated on future dates to allow finance.yahoo.com to deal with share splits and dividends. A set of assumptions and protocol for estimating delisting returns for constituents replaced due to a merger or acquisition would need to be developed.

PROCESS LIMITATIONS AND IMPLEMENTATION CONSIDERATIONS

While we have not experienced changes in the website addresses used in the process, we have experienced some changes and issues within the Select Sector SPDR ETF and finance.yahoo.com websites. In this section, we describe these

experiences, the potential for other issues, and suggestions for implementation. We also emphasize limitations of the process that would make it unsuitable for professional money managers' use.

With respect to the Select Sector SPDR ETF website, although the availability of data elements has been consistent, the site's appearance changes periodically to incorporate new features. For example, in October 2015, State Street Bank and Trust Company added two ETFs to allow investors options to partition the financial sector into separate Financial Services (ticker: XLFS) and Real Estate (ticker: XLRE) sectors. Data for the Financial Sector ETF (ticker: XLF) remain available as before. But 11 sectors rather than 9 sectors appear on the website. As long as the two new ETFs are ignored, the process remains as described in this paper. Using all 11 sectors would be incorrect, however, as financial firms would be double counted.

The other change we experienced with the Select Sector SPDR ETF website is in the Excel file format of the data for constituent weights. Sometimes the data for weights download as text strings rather than numbers and require conversion (e.g., using Excel's "value" function).

With respect to the finance.yahoo.com website, which the process uses to obtain historical price data, there are three issues worth considering. First, occasionally we have observed gaps in daily data. For example, in 2013, we experienced several weeks during which historical price data were missing for several trading dates for some trading symbols in prior months but then appeared later. Second, when a company merges, as in the case of Kraft and Heinz to form a single company with a new trading symbol, historical price data for the prior companies are no longer accessible, even for the period the company's stock traded. For example, historical price data for Kraft (ticker: KRFT), which were available on finance.yahoo.com until the merger date of July 2, 2015, are no longer accessible on the finance.yahoo.com site. Third, we have experienced occasionally that SAS program download attempts from the website have "timed out" without successfully downloading the data. For these three reasons, when we automated the process, we included quality control checks and alerts for missing trading dates and missing trading symbols.

It is worth noting for those that have not worked with the finance.yahoo.com historical price data that adjusted close prices on the website are backward updated. Thus, each time historical prices are obtained, the entire history needs to be updated, not just the most recent date's prices.

As mentioned in the Extensions section, the process could be set up to run after the close of trading each day as a batch process. In any event, implementation of the process should take into account time coordination between the end-of-day updates by the Select Sector SPDR ETF and finance.yahoo.com websites. In our experience, the updates are completed by midnight but the exact time of updates prior to midnight varies.

Finally, it is worth emphasizing to students that the level of detail and accuracy required by professional money managers goes beyond that obtained with the process. To the extent that S&P Dow Jones Indices makes changes in constituents between date t and the current date, some of the constituents on date t will be in error. The impact of these changes on the estimates of weights and returns depends on the weights of the changed constituents (e.g., replacing companies that have the largest market capitalizations will have a greater impact than those with smaller market capitalizations) as well as how closely the backfilled price data approximate the returns of the replaced constituents. Also, S&P Dow Jones Indices periodically reweights the S&P 500 index to account for dividend reinvestment, etc., which the process does not attempt to replicate. In addition, although the process can be used to estimate data for the S&P 500 index, there are many other U.S., international, and emerging equity market indexes as well as other asset class indexes (e.g., fixed income and commodity) for which the process has not yet been adapted to estimate. The process does not attempt to replace the data services that provide real-time and historical index data to which professional money managers subscribe.

ASSURANCE OF LEARNING

Before using the process described in this paper, we created Excel spreadsheets of the S&P 500 constituents, weights, and sector maps for students rather than asking them to create their own. We used several alternatives for creating the spreadsheets to provide to the students. Initially, we created constituent lists and sector maps annually using CRSP and Compustat; and we were able to update sector weights and returns throughout the year using freely available data on an S&P website. After several years S&P made a change so that the sector information was accessible only for paid subscriptions. We then found the Select Sector SPDR ETF website and periodically recorded sector weights, and we used the sector ETF adjusted close prices from the finance.yahoo.com website to estimate sector returns.

Several years ago we implemented the learning activity that asks students to create their own Excel spreadsheets. Our experience has been that students' understanding of the index and its use as a benchmark for portfolio analysis improves dramatically when they create their own spreadsheets. In addition to observing anecdotal evidence (e.g., students were more likely to discuss diversification in terms of both sectors and stocks rather than stocks alone), we measured changes in learning outcomes by posing the following problem to students during 4 consecutive semesters.

Students were asked to analyze whether Apple's stock was over-weighted or under-weighted in the investment program's portfolio relative to the S&P 500 benchmark. Each semester, the portfolio held more than 30 stocks (including

Apple) in addition to all 9 Select Sector SPDR ETFs along with another technology ETF (which included Apple as a holding). Because Apple was held in the portfolio outright, most students' priors were that the portfolio was over-weighted in Apple and that outperformance of Apple's stock return would be positive for the portfolio relative to the benchmark. However, each semester, after taking into account the weights of the other holdings and Apple's weights in the ETFs, Apple was actually underweighted in the portfolio relative to the S&P 500 benchmark.

In the first 2 semesters, students were given the S&P 500 index constituent spreadsheet and did not perform the learning activity. Students were allowed to work in teams. None of the teams correctly analyzed the problem without assistance. During the last 2 semesters, students performed the learning activity to create their own spreadsheets and then were asked to analyze the problem. Again students were allowed to work in teams. Without assistance, 6 of 8 teams correctly analyzed the problem in one semester and 7 of 8 teams correctly analyzed the problem in the other semester.

CONCLUSION

This paper provides a method for estimating current and historical constituent and sector data for one of the most commonly used equity indices: the S&P 500. While the method does not produce the level of detail and accuracy required by professional money managers, we believe the method provides estimates that are close enough to actual data to be used in students' coursework. If a greater degree of accuracy is needed but index subscriptions are unaffordable, a batch updating protocol, as described in the "Extensions" section of this paper, could be used to improve the accuracy of the estimates.

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Appendix: Automation Using SAS

We automate the process for obtaining current and historical index data using SAS. Critical elements for the program are the URLs for the Select Sector SPDR ETF holdings, for the estimates of the weight of each sector in the S&P 500 index, and the historical price data from finance.yahoo.com.

The URL for the Select Sector SPDR ETF holdings data for the Consumer Discretionary sector (ticker: XLY) is: http://www.sectorspdr.com/sectorspdr/IDCO.Client.Spdrs.Holdings/Export/ExportCsv?symbol=XLY

Manually copying and pasting this into the web browser address window, then entering return, opens the holdings-XLY.csv file. This is the same data as in the Excel files downloaded by the students in the learning activity. We write a SAS macro to loop through each of the 9 ETF tickers, one at a time, and use a macro variable 'SYM', which is the ETF ticker. For testing purposes, before writing the loop for all 9 tickers, we verify the results for ticker XLY. Our SAS code is:

```
%Let SYM = XLY;
filename foo1 url "http://www.sectorspdr.com/sectorspdr/IDCO.Client.Spdrs.Holdings/Export/ExportCsv?symbol=&SYM";
data getdat1;
length ticker $8 name $36 weight1 $8 weight2 $8;
infile foo1 delimiter="," firstobs=3;
input ticker name weight1 weight2;
run;
```

The first 15 observations for SAS temporary dataset **getdat1** created after the close September 14, 2015 are:

	ticker	name	weight1	weight2
1	"AMZN"	"Amazon.com Inc"	"8.86%"	"521.38"
2	"DIS"	"Walt Disney Co"	"7.22%"	"103.82"
3	"HD"	"Home Depot Inc"	"6.64%"	"114.73"
4	"CMCSA"	"Comcast Corp"	"6.30%"	"56.25"
5	"MCD"	"McDonald's Corp"	"4.14%"	"96.97"
6	"SBUX"	"Starbucks Corp"	"3.76%"	"56.29"
7	"NKE"	"NIKE Inc B"	"3.47%"	"111.89"
8	"PCLN"	"The Priceline Group Inc"	"2.97%"	"1286.83
9	"LOW"	"Lowe's Cos Inc"	"2.83%"	"68.15"
10	"TWX"	"Time Warner Inc"	"2.56%"	"69.63"
11	"F"	"Ford Motor Co"	"2.44%"	"13.78"
12	"TWC"	"Time Warner Cable Inc"	"2.35%"	"187.06"
13	"TGT"	"Target Corp"	"2.19%"	"77.15"
14	"TJX"	"TJX Cos Inc"	"2.16%"	"71.21"
15	"FOXA"	"Twenty-First Century Fox	Inc"	"2.07%"

Observation 1 shows that Amazon has a weight of 8.86% in XLY as of September 14. The closing price is $521.38/share. The reason for specifying 2 weight variables (*weight1* and *weight2*) in the input command is to deal with the fact that the infile is comma delimited. This causes an issue when the company name has a comma (e.g. "Twenty-First Century Fox, Inc"). Subsequent data steps strip the quotation marks and check whether *weight2* should be used instead of *weight1*.

The URL for the estimate of the weight of the sector in the S&P 500 index for ticker XLY is: http://www.sectorspdr.com/sectorspdr/api/pie-data/XLY
Our SAS code is:

```
filename in url "http://www.sectorspdr.com/sectorspdr/api/pie-data/&SYM";
data getdat2;
infile in length = reclen lrecl = 10000;
input @;
input @1 lstrip $varying10000. reclen;
run;
data step2;
length Word $ 24.;
set getdat2;
      do i = 1 to 10;
      word = scan(lstrip, i,' " : , { } ');
      output;
      end;
run;
```

```
data keepme2;
set step2;
First1 = substr(left(reverse(word)),1,1);
if First1 = '%';
wt_in_sector = (translate(word, ' ', '%') +0)/100;
keep wt_in_sector;
run;
```

SAS temporary dataset **getdat2** has one observation and one variable (lstrip). For SYM = XLY:

	lstrip
1	{"symbol":"XLY","estimateWeight":"13.03%","lastUpdate":"09/14/2015"}

The subsequent data steps (**step2** and **keepme2**) store 0.1303 as variable *wt_in_sector* in dataset **keepme2**. Subsequent data steps merge the sector holdings dataset (constituent names, tickers, and weights within the sector) with dataset **keepme2**. SAS macro functions loop through all 9 tickers, stack the 9 ETF datasets to create a single dataset, and perform the multiplication (i.e., multiply constituent weight in the sector by sector weight in the index) to obtain each constituent's weight in the S&P 500 index. We check that the constituent weights and sector weights sum to 100% using *proc means* statements.

We write a SAS macro to obtain adjusted close prices from finance.yahoo.com. For the SAS macro, we loop through each of the constituents in the S&P 500 index, obtained in the last section, one at a time, using a macro variable 'TICK', which is the constituent's ticker. For testing purposes, before writing the loop for all 502 tickers, we verify the results for Amazon (ticker: AMZN).

The URL for the adjusted close price data is: http://ichart.finance.yahoo.com/table.csv?s=AMZN&g=d

Our SAS code to verify the results for Amazon is:

```
%let TICK = AMZN;
filename yahoo1 url "http://ichart.finance.yahoo.com/table.csv?s=&TICK&g=d" ;
data yahooF;
infile yahoo1 delimiter="," firstobs=2;
input date : yymmdd10. open high low close volume adjClose;
format date mmddyy10.;
format open high low close adjClose 12.4;
run;
```

The first 6 observations for SAS temporary dataset **yahooF** created after the close September 14, 2015, are:

	date	open	high	low	close	volume	adjClose
1	09/14/2015	529.4400	532.4500	518.5800	521.3800	3127100	521.3800
2	09/11/2015	521.0700	529.4400	520.6100	529.4400	3218600	529.4400
3	09/10/2015	515.1500	526.1300	514.7800	522.2400	2562800	522.2400
4	09/09/2015	524.0000	529.9500	515.0600	516.8900	4338700	516.8900
5	09/08/2015	508.6900	518.3500	508.5100	517.5400	3777500	517.5400
6	09/04/2015	497.6500	502.8500	495.6400	499.0000	2690200	499.0000

Amazon's adjusted close prices (variable adjClose) for 9/14/2015 and 9/11/2015 were $521.38/share and $529.44/share, respectively. Subsequent data steps use the variable adjClose and lag functions to calculate daily holding period total returns.

Automated Grading of Excel Assignments

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Spreadsheet assignments can enhance student learning but also place a substantial grading burden on instructors. We present a grading program for customized spreadsheet assignments focused on reducing that grading burden, while advancing student learning by providing quicker feedback. The grading program innovates on existing approaches and can handle new or revised assignments. Grade time averages 6.2 seconds per student file for our sample, with the grader running at its quickest setting. Comparison of manual and autograder scoring provides evidence that the auto-grader marks student work more accurately.
Keywords: Automated grading, Excel, spreadsheet skills, assessment

INTRODUCTION

Excel assignments can improve student spreadsheet skills, which many employers value, and strengthen our students' understanding of related course material, such as financial statements and option pricing (e.g., Cagle, Glasgo, & Hyland, 2010; Ghani & D'Mello, 1993; Kline & Janicki, 2003; and Wann, 2015). However, traditional manual grading of these assignments is often a mundane and laborious task, which likely discourages many faculty from incorporating student Excel work into their courses. Manual grading also tends to frustrate the prompt delivery of feedback to students, which is thought to enhance learning (e.g., Epstein, Epstein, & Brosvic, 2001; Gagne, Briggs, & Wager, 1992). With class size increasing for many courses, these issues are arguably becoming more acute over time.

In recognition of the problems associated with manual grading of Excel assignments, a number of automated grading programs have been developed and presented in the academic literature. Each of these programs have their strengths and potential drawbacks. For example, the grading program of Hill (2003) scores student files quickly with minimal setup, but offers somewhat limited flexibility in the scoring of student work. The program of Matthews, Janicki, He and Patterson (2013) provides customized feedback and partial credit for student errors, but requires that the instructor visually inspect each unique student response. The

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varying strengths and potential drawbacks of existing programs opens the door to continued innovation.

This paper presents a grading program for customized Excel assignments that combines and innovates on the approaches of Matthews et al. (2013) and McNeil (2015). The program allows the instructor to balance grading speed against the additional time and effort required to provide more detailed feedback and partial credit to students, based on the instructor's preferences for the assignment. We have employed the program to grade cell referencing (relative, absolute, and mixed), time value functions, IFs, nested IFs, VLOOKUPs, SUMIFS, Pivot Tables, and other general formulas. Output from the program includes a new worksheet inserted into each student's file listing each item graded, whether correct, and the percentage score for the assignment. Incorrect cells within student files are highlighted, and a summary of all student scores is generated as well, for ease of uploading to a course management system like Moodle. When desired, the instructor can also provide customized feedback and partial credit for student errors. Setup time for new assignments is moderate. The grading program is available from the author upon request as an Excel addin.

The remainder of the paper is organized as follows. The next section contains a discussion of existing automated grading systems for spreadsheet assignments. In section 3, we present our grading program. Section 4 concludes.

EXISTING AUTOMATED GRADING SYSTEMS

Several textbook publishers offer systems that assist with spreadsheet assignment grading, including the MyLab products of Pearson, McGraw-Hill's SIMnet, Cengage Learning's SAM, Paradigm Education Solutions' SNAP, and John Wiley & Sons' Excel Grader. With the exception of Excel Grader, these systems primarily rely on a simulated environment, offering the advantage of real time feedback and real time recording of grades. Publisher systems have generally improved over time. For example, early versions of SNAP and SAM recorded and evaluated a student's keystrokes (Hill, 2003; and Matthews et al., 2013), allowing students little room to deviate from a prescribed order of operation. Currently, to evaluate student formulas, most publisher grading tools appear to compare a student's finished formula as a text string to a solution set text string, with only exact or close matches counted as correct, ignoring the formula's output—a method that is overly restrictive in our opinion. To compensate, the systems allow the instructor to offer students multiple tries in real time, with an adjustable deduction for earlier misses. Among these publisher graders, only Excel Grader accommodates customized spreadsheet assignments. However, Waldman and Ulema (2008) note that Excel Grader, then known as MEAGER (Hill, 2003), suffers from an overly restrictive grading problem. Additional discussion of Excel Grader appears further below.

A number of automated grading programs for spreadsheet assignments are also presented in the academic literature. For example, Kline and Janicki (2003), Blayney and Freeman (2004), Waldman and Ulema (2008), and Kovacic and Green (2012) present programs designed for specific assignments. The Blayney and Freeman (2004) and Kovacic and Green (2012) programs provide students feedback in real time. Blayney and Freeman's program also generates a customized spreadsheet file for each student's work. All four require the instructor to modify the computer code of the grading program to accommodate new or updated assignments.

Hill (2003), Matthews et al. (2013), Bertheussen (2014), and McNeil (2015) present automated graders designed to accommodate instructor generated spreadsheet assignments, requiring no modification of the grader's computer programing. Each of these graders have their strong points, as well as potential drawbacks. Hill's (2003) system is now known as Excel Grader (formerly known as MEAGER) and is licensed to John Wiley and Sons. Excel Grader is an Access based program that extracts information from student files and grades by comparing student work to information obtained from a designated solution file. A trial version can be accessed at http://www.wiley.com/college/sc/office2013/officegrader.html. It evaluates such things as formulas, formatting, numbers, and cell orientation, and has advanced plagiarism detection, relative to other graders. Feedback of a somewhat generic nature (e.g., correct formula from the solution file) is provided as an Excel comment in any cell with a perceived error. The grader very easily accommodates new or updated assignments. The instructor need only point the grader to the solution workbook and the student files to be scored. The program processes student files without any additional input from the instructor. Regarding potential drawbacks, Waldman and Ulema (2008) note that Excel Grader scores student work in an overly restrictive manner in some cases, as stated earlier. To check this claim, we use Excel Grader to mark a set of student files and find evidence that Excel Grader continues to evaluate formulas in an overly restrictive manner. In addition, Excel Grader does not offer the flexibility of partial credit (a given cell is either correct or incorrect) or of varying point values across cells—features that may be important to an instructor for some assignments.

Matthews et al. (2013) Adaptive Grading/Learning System (AGLS) is an ASP.Net (VB) program that can evaluate such things as charts and Solver, in addition to formulas and cell formatting. AGLS grades student work by comparing student responses to a list of responses previously evaluated by the instructor. If an exact match is found in the list, the student's response is marked in accordance with its exact match. If no exact match is found, AGLS prompts the instructor to visually inspect the response and to assign a grade and feedback. The response is then added to the list of evaluated responses for future reference. In this way, the instructor can provide partial credit and customized feedback for each incorrect answer, which no earlier automated graders that we know of allow. A drawback

of AGLS is that new or materially updated assignments require instructor time to build or rebuild the response list as the program scores student work. To the best of our knowledge, the AGLS grader is only available to faculty members at the University of North Carolina Wilmington.

Bertheussen's (2014) grading program has the capability, at the instructor's option, to provide real-time feedback and customized problems for each student, unique among these four grading tools. Customized student problems are intended to encourage students to do their own work. Another innovative aspect of Bertheussen's grader is that it can accommodate problems in which a template is not completely set. Instead, a student must decide what items to include and how to then construct formulas within a designated range of cells. The program can automatically provide partial credit for incorrect answers by awarding points for referencing designated cells in formulas, ignoring how the cells are used. The grading program evaluates formulas and cell values, requiring no additional instructor input after setup, and is available from its author upon request. Potential drawbacks include new assignment setup time and evaluation of hardcoding. Setup of new assignments appears to require a material amount of time. The grader does not mark hardcoding within formulas—Powell, Baker, and Lawson (2009) find that hardcoding is one of the most common errors in spreadsheets.

McNeil (2015) presents a grader designed to evaluate custom modeling assignments such as the construction of forecasted financial statements and is available from its author. The program scores numeric formulas only and does so by a process of copying each student formula to a duplicate solution worksheet for comparison to a master solution worksheet. To accurately score IF statements and hardcoding within formulas, the grader allows the instructor to use several alternative values for the modeling assignment's input assumptions (e.g., varying levels of sales growth, cost of goods sold, and inventory turnover). Instructor setup time for new assignments appears to be moderate and the program quickly evaluates student work. However, feedback is limited to an overall score and the highlighting of incorrect cells (no partial credit, each cell is marked as either correct or incorrect). In addition, evaluation is limited to a single worksheet within each student file.

In summary, each of the four preceding grading programs have strengths and potential drawbacks. The programs of Hill (2003) and McNeil (2015) have the advantage of ease of accommodating new assignments and speed of grading. Matthews et al. (2013) does the best at providing detailed feedback and partial credit. Bertheussen (2014) is the better of the four at providing an option for real-time feedback and customized problems across students. The varying strengths and potential drawbacks across the four grading programs open the door to continued innovation.

THE GRADING PROGRAM

For ease of reference, we will refer to our grader of customized Excel assignments as the Spreadsheet Scoring Program (SSP). SSP is a VBA program that combines and innovates on the approaches of Matthews et al. (2013) and McNeil (2015). The former provides customized feedback and partial credit, but at the expense of additional instructor grading time. The latter approach scores student files quickly, but does not provide customized feedback or partial credit. By combining the two approaches, SSP gives the instructor the flexibility to grade assignments very quickly or to forfeit some of that grading speed in order to provide students more feedback and partial credit. The instructor can decide which approach works best for themselves and their students for each assignment. Setup time to evaluate new assignments is moderate and the program incorporates a number of innovations to improve grading efficiency. Next, we highlight what the program can grade, then discuss the general mechanics of grading, grading output, and efficacy.

WHAT SSP GRADES

SSP is designed to grade most any cell formula and to accommodate new or updated assignments. No programming is required by the instructor. We have used SSP to grade cell referencing (relative, absolute, and mixed), Excel conditional and reference functions (e.g., IFs, nest IFs, VLOOKUPs, SUMIFS, and COUNTIFS), short modeling problems, Pivot Tables, and other general Excel functions. The grader also detects hardcoding within formulas. SSP, in its current version, does not grade charts or cell formatting.

GRADING MECHANICS: QUICK METHOD

With SSP, instructors have the option of grading each item using the QUICK method, the LIST method, or both. As its name suggests, the QUICK method is the faster of the two methods. When the QUICK method is solely employed, SSP, once initiated, requires no additional input from the instructor as the program marks all student files. Cells are scored as either correct or incorrect (no partial credit) and incorrect cells are highlighted. The QUICK method resembles the approach of McNeil (2015) and works as follows. SSP automatically creates two duplicates of the instructor's solution file (we refer to these below as key 1 and key 2). So that hardcoding within cell formulas will be detected, SSP automatically changes the values in nonformula numeric precedent cells of the items selected for grading (one innovation to the McNeil (2015) approach). The program evaluates student formulas, one at a time, by copying them to key 2 and comparing the resulting

values to that of key 1. A student's formula is judged to be correct if the two values are within 99.95% of each other (to allow for potential rounding in Excel, as in McNeil (2015)). If the values are text, the two values must match exactly, ignoring case. The instructor may also require that students use a particular function within a formula, such as SUM or SUMIFS.

To properly evaluate conditional and reference formulas (e.g., IFs and VLOOKUPs), the QUICK method uses what we call the "copy to" procedure. For example, a student's IF formula would be copied to additional designated cells in duplicate key 2 to ascertain whether the student's work produces results appropriate for a correct conditional formula. The copy to procedure also enables the QUICK method to evaluate whether absolute, relative, and mixed cell referencing is correctly employed by students, if the instructor wishes. To our knowledge, no other grading program for customized Excel assignments can automatically evaluate such cell referencing without instructor input while running.

To reiterate, the primary advantages of SSP's QUICK method are speed of grading and accurate scoring. Average SSP run time using the QUICK method is 6.2 seconds per student file in our sample (average number of cells graded per assignment = 67). The QUICK method does not, however, offer partial credit for individual cells or customized feedback. If desired, the instructor can provide partial credit and additional feedback by selecting the LIST method of grading, at the expense of increased grading time. It is up to the instructor to decide whether the benefits of partial credit and additional feedback warrant the costs of increased grading time.

GRADING MECHANICS: LIST METHOD

The LIST method option within SSP is based on the approach of Matthews et al. (2013) and evaluates student formulas as a text string (e.g., =PMT(E17/12,E19*E15,−E13,,1)). A student's formula text string is compared to a list of responses previously evaluated by the instructor and cataloged by SSP. When an item is graded using both the QUICK and LIST methods, only incorrect student formulas are passed to the LIST method, an innovation to the Matthews et al. approach that speeds up grading. The catalogued list of responses is housed in a designated worksheet within the instructor's solution file. If an exact match is found, the student's response is automatically marked as its exact match has been catalogued. If no exact match is found, the program prompts the instructor to input a percentage correct and feedback for the student response. It is this prompting for instructor input for previously unseen errors that primarily accounts for the increased grading time for the LIST method relative to solely using the QUICK method. The instructor inputs are added to the response list for future use, similar to Matthews et al. (2013). As shown in Figure 1, the SSP user interface for evaluation of an unmatched response displays the formula and cell value for both

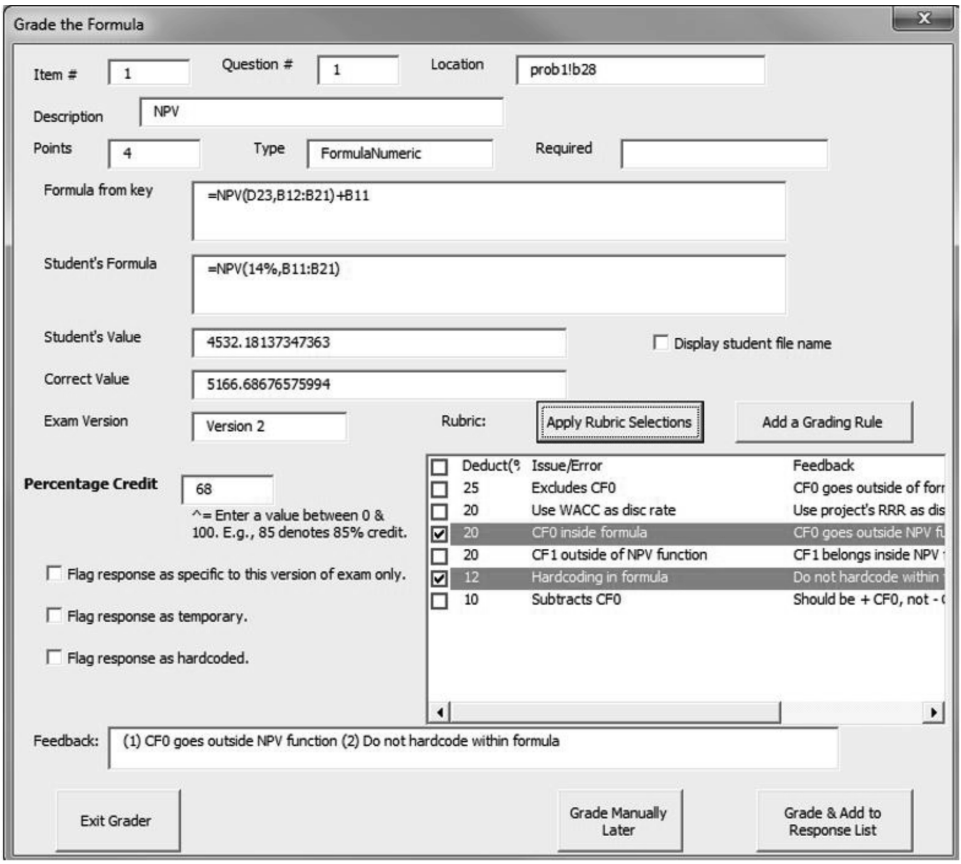

Figure 1. LIST Method User Interface for Evaluating an Unmatched Response.

the student and the solution, for the instructor to visually compare, along with the question's description and point value. To reduce potential bias in grading, the student's identity is not shown, but can be displayed if needed.

To facilitate more efficient and consistent instructor evaluation of student work using the LIST method, SSP works through each question in turn for all students (e.g., grades all student responses for a given question before moving on to the assignment's next question), and utilizes a grading rubric—two enhancements to the AGLS program described by Matthews et al. (2013). The grading rubric lists percentage deduction and feedback for common student errors for the given question, and is displayed in the lower right of the SSP LIST grading user interface (see previous Figure 1). SSP uses instructor rubric selections for the student response being evaluated to compute percentage correct and compose feedback text. For future use and ease of editing, a designated worksheet within the solution file houses the grading rubric list for all questions. The grading rubric can be amended before or during grading runs.

QUICK OR LIST

As stated earlier, in SSP the instructor has the option of grading each item using the QUICK method, the LIST method, or both. The advantage of the QUICK method is speed of grading, and, thereby, the greatest time savings for the instructor. The advantages of the LIST method are more detailed feedback and the ability to award partial credit. At the end of the day, it is the up to the instructor to determine what works best for them and their students for each assignment. SSP provides this flexibility.

One approach is to use the QUICK method (opting out of the LIST method) for out of class assignments, since it is the more efficient grading method in terms of time to grade. QUICK's grading speed facilitates having students correct and resubmit their work. In this way, students can better learn from their own mistakes. The final score for an assignment could be some weighted average of the student's submissions. Furthermore, the QUICK method handles changes in assignments from semester to semester more efficiently than the LIST method.

We tend to use the LIST method (in combination with the QUICK method) to score proctored exams, given our desire to provide partial credit for student mistakes in that setting. Our experience has shown that LIST method grading for an initial batch of 30 or so student files for a new assignment takes about as much time as grading manually. LIST grading speed increases materially with each additional batch (as the number of catalogued student responses increases), but will rarely ever match the speed of the QUICK method.

GRADING OUTPUT

SSP produces three outputs: (1) a grade sheet for each student; (2) marked student Excel files; and (3) summary scoring for all submissions as a group. With a quick look at their grade sheet, a student sees their overall score and which items they missed. The grade sheet lists each item graded, a brief item description, point value, points earned (with a check or an "x" to denote correct and incorrect answers), and the student's total percentage score. Figure 2 displays a grade sheet where the instructor has opted to provide partial credit and feedback verbiage for errors (combination of QUICK and LIST grading methods). Output for questions 6 to 11 are hidden to conserve space. Student grade sheets can easily be uploaded to a course management system like Moodle or printed out.

Marked files are the second grading output. SSP highlights each cell that is incorrect within each student's submitted file. Marked student files are saved to a separate folder. The Moodle course management system allows marked files to be easily returned to students in a single zipped batch (if students submitted their files using Moodle's assignment feature). It appears that Blackboard works similarly, but we do not have firsthand experience with Blackboard's system.

Excel Assignment #1						
Name:	Doe, Jane					
File:	JaneDoe.xlsx					
Question	Description	Location	Points	Score		Comments
1	NPV	prob1!b28	6	4.80	x	Use prroject's RRR
1	IRR	prob1!b30	5	5.00	✓	
1	MIRR	prob1!b32	6	6.00	✓	
2	Cell References	prob2!c19	5	5.00	✓	
3	PMT	prob3 - 7!e21	6	4.98	x	Use cell references for all inputs
4	XNPV	prob3 - 7!f57	6	4.80	x	Use project's RRR
5	Sumifs	prob3 - 7!e95	6	5.10	x	Use "?" as wildcard character
12	VLookup 2 - - cell 1		7	7.00		
	VLookup 2 - - cell 1	prob12!h10			✓	
	VLookup 2 - - cell 11	prob12!h20			✓	
	VLookup 2 - - cell 20	prob12!h29			✓	
	Totals		84.00	**70.20**		
	Percentage Score			**83.57**		

Figure 2. LIST/QUICK Methods Grade Sheet Output for a Student.

The third SSP output is a summary of all scores in a new worksheet, one row per graded student file showing student scores, plus student formulas and scores for each graded item (see Figure 3). This summary output allows for efficient uploading of assignment scores and assessment analysis by graded cell.

SETTING UP ASSIGNMENTS FOR GRADING

Set up for the grading of new assignments involves no VBA programming. The instructor provides grading directions to SSP in a worksheet (inserted into the

	A	B	C	D	E	F	G	H
3	Date Graded	File Name	Last Name	First Name	Student ID#	Version	Total Score (max = 78)	Percentage Correct
4	7/3/2014	student1.xlsx	Doe 1	Jane	90000001	1	53.10	68.08
5	7/3/2014	student2.xlsx	Doe 2	Jane	90000002	2	73.80	94.62
6	7/3/2014	student3.xlsx	Doe 3	Jane	90000003	2	38.05	48.78
7	7/3/2014	student4.xlsx	Doe 4	Jane	90000004	1	78.00	100.00
8	7/3/2014	student5.xlsx	Doe 5	Jane	90000005	2	77.10	98.85
9	7/3/2014	student6.xlsx	Doe 6	Jane	90000006	2	74.10	95.00

Figure 3. SSP Summary Grading Output.

solution file), listing the location of each cell to be graded, point value, question description, type of question, grading method, etc., as partially shown in Figure 4. Another six inputs, not shown to conserve space, are yes/no selections (e.g., QUICK Grade, yes/no; LIST Grade, yes/no). Roughly speaking, inputting set up directions is expected to take less than one hour (depending on the assignment's complexity), and once completed, can be used for subsequent grading runs of the assignment.

	A	B	C	D	E	F	G	H	I
5	Item	Question	Group	Description	Type	worksheet	cell	Required Function	points
6	1	1	1	NPV	FormulaNumeric	prob1	b28		6
7	2	1	2	IRR	FormulaNumeric	prob1	b30		5
8	3	1	3	MIRR	FormulaNumeric	prob1	b32		6
9	4	2	4	Cell References	FormulaNumeric	prob2	c19		5
10	5	3	5	PMT	FormulaNumeric	prob3 - 7	e21		6
11	6	4	6	XIRR	FormulaNumeric	prob3 - 7	e36		6
12	7	5	7	XNPV	FormulaNumeric	prob3 - 7	f57		6
13	8	6	8	FV	FormulaNumeric	prob3 - 7	f74		6
14	9	7	9	Sumifs	FormulaNumeric	prob3 - 7	e95	sumifs	6
15	10	8	10	VLookup 1 - - cell 1	FormulaText	prob8	i10		3
16	11	8	10	VLookup 1 - - cell 14	FormulaText	prob8	i23		2
17	12	8	10	VLookup 1 - - cell 31	FormulaText	prob8	i40		2

Figure 4. SSP Grading Setup Information.

EFFICACY

To test the efficacy of SSP, we first compare scoring results from SSP grading and manual grading and then discuss speed of grading. The sample consists of all Excel exams, from a single course across semesters, that had originally been graded manually (before the development of SSP) and where graded hard copies of the exam and student Excel files are still available. The number of exams is 217, coming from 4 semesters. The content of the exams varies somewhat across semesters and include Excel functions like NPV, MIRR, RATE, AND, IF, and VLOOKUP, as well as short modeling problems. Parts of the exams not amenable to automated grading are excluded (e.g., questions that allowed free form work by students, as opposed to limiting work to a designated cell range). After this exclusion, the sample of 217 exams contains 16 auto-gradable questions and 3118 student responses (not all semester exams include all 16 questions). The number of cells evaluated per question ranges from 1 to 65. Manual grading scores for each of the individual 16 questions are collected from the hard copies of the exams, as originally marked. Exam scores are recalculated, limiting consideration to the 16 questions. Each of the 217 exams are re-graded using SSP, employing the QUICK and LIST methods in combination, since the original manual grading included partial credit for student mistakes. The manual and SSP results are matched by student for paired difference statistically testing.

The difference in average scores statistically differs from zero, but is relatively small. On a 100 point scale, average exam scores are 85.45 for manual grading and 82.05 for SSP, a difference of 3.40 that is statistically significant at the 1% level. The correlation between the exam scores is quite strong at 0.879 and statistically significant. Analysis at the question level reveals similar results. Using a 100 point scale for each question (point values vary across questions), average question scores are 86.72 for manual grading and 83.62 for SSP. The difference of 3.10 is statistically different from 0 at the 1% level. The correlation between the question scores is 0.838 and statistically significant. Thus, the SSP scores tend to be very similar but somewhat lower than the manual scores for the sample.

Additional analysis of the difference of question scores (with each question on a 100 point scale) for the 3118 student responses shows that a majority (66.0%) fall within +/−5 points, and 75.7% fall within +/−10 points (results not tabulated). To gain insight into the cause of scoring difference, we take a random sample of 100 student responses for individual questions where manual and SSP grading differs by 10 points or more on a 100 point scale. Table 1 lists the primary cause of question scoring variance, grouped by source of variance (SSP, manual, and other) and ordered by frequency of occurrence. Column (2) lists frequency and column (3) contains Average Absolute Scoring Difference (the average absolute difference in scoring between manual and SSP grading on a 100 point scale for the randomly selected sample of student answers).

For the 100 randomly selected responses, manual scoring is found to be at fault for 65 responses, SSP auto-scoring for 16 responses, and "other" for 19 responses. These frequency results provide evidence that SSP scores more accurately than manual grading for our sample. Based on the Average Absolute Scoring Difference, an occurrence of "other" causes the greatest difference in scoring between manual and auto-grading (a difference of 37.7 on average, which would translate to almost 4 points on a 10 point question). This "other" source of variance consists of students working outside of the designated area for a question. The frequency of work outside the designated area and its impact on scoring indicates the importance of stressing to students that all work must be done in designated cells when scoring with SSP, or any other auto-grading system of which we know.

The primary deficiency for manual scoring, based on frequency, is the overlooking of hardcoding within student formulas, the case for 29 responses. In four other cases, manual grading overlooked a student error other than hardcoding. Per occurrence, the largest source of scoring difference for manual grading is excess partial credit (Average Absolute Scoring Difference = 30.6), which accounts for 21 responses in the sub-sample. In general, excess partial credit arises when an answer is marked incorrect but some aspect of what is incorrect is overlooked or the instructor misapplies their grading rubric.

Table 1. Causes of Scoring Variance between Manual and SSP Grading.

Cause of Scoring Variance	Frequency (1)	Average Absolute Scoring Difference (2)	Average Frequency x Absolute Scoring Difference (3)
SSP Grading			
Excess deduction (LIST method)	2	32.4	64.8
Excess partial credit (LIST method)	13	26.2	341.1
Missed student error (QUICK method)	1	25.0	25.0
Total	16	26.9	430.9
Manual Grading			
Excess deduction	11	17.3	189.9
Excess partial credit	21	30.6	642.0
o deduction for hard-coding	29	17.5	506.8
Missed student error	4	18.8	75.2
Total	65	21.8	1,413.9
Other			
Student work outside designated area	19	37.7	715.4
Total	100		

The primary deficiency for SSP scoring, based on frequency, is excess partial credit (13 responses). Human error can impact SSP LIST grading as the instructor evaluates student responses for the assignment of partial credit. In one case, the SSP QUICK method overlooked a student error, when a precedent cell had a value of zero but should have been referenced. Per occurrence, excess deduction is SSP's largest source of scoring error (Average Absolute Scoring Difference = 32.4) for the sub-sample. SSP excess deduction, as with SSP excess credit, is the result of human error during LIST grading; however, it only occurs twice in the subsample.

Table 1's column (3) shows the combined impact of frequency and scoring difference, as the product of the two. The product is equivalent to the sum of absolute scoring difference. Student work outside of designated area has the largest combined impact among the individual line items (715.4). Next highest is excess partial credit under manual grading at 642. Overall, manual grading has the largest combined impact at 1,413.9, while the combined value for SSP grading is 430.9. Taken together, the results from the random sample indicate that SSP grades more accurately than manual grading.

For insight into SSP's potential for grading speed, we employed the program's QUICK method to re-score the sample of 217 exams taken from 4 prior semesters. Recall that a primary advantage of the QUICK method is speed. QUICK marks each student cell selected for grading as right or wrong, with no partial credit, and generates the three SSP outputs discussed earlier (e.g., see earlier Figure 2). Since the exams differ somewhat over time, one grading run is conducted for each semester. SSP computer grading time is measured for each grading run. In

addition to the computer grading time, it should be noted that the instructor must spend some time setting up the grading run (i.e., entering locations of cells to be graded and point values into a setup worksheet, which can be used or modified for future runs if the exam is changed) and should conduct a test run on a few files. As stated earlier, we roughly estimate that this pre-run setup takes less than one hour for a new assignment once an instructor becomes familiar with the system. Pre-run setup time is independent of number of files to grade.

For the 4 sets of exams in our sample, SSP computer grading time per exam ranges from 3.8 seconds to 9.4 seconds, averaging 6.2 seconds. Grading was performed on a Dell laptop with 16 gigabytes of RAM and a 2.7 gigahertz processor, running Excel 2013. The longest time corresponds to an exam that includes a pro forma financial statement problem with circular references, which requires more processing time within Excel in general. On a per cell graded basis (where total cells graded for an exam run equals the product of number of exams and cells graded per exam), QUICK grading time ranges from 0.09 seconds to 0.32 seconds, averaging 0.14 seconds for our sample. Thus, SSP can grade assignments quickly.

CONCLUSION

Including spreadsheet assignments in our coursework enhances student Excel skills, which are valued by many employers, and can improve student understanding of underlying course topics. For the instructor, manual grading of Excel assignments is generally time consuming and laborious, providing an incentive for the development of automated graders. By increasing grading efficiency, auto-grading can also speed up the return of feedback to students and facilitate the assignment of more Excel work to students, thereby, improving student learning. Existing grading programs for customized Excel assignments each have their strengths and potential drawbacks, which opens the door to continued innovation.

The grading program presented in this paper combines and innovates on the approaches of Matthews et al. (2013) and McNeil (2015), providing the instructor the option to use either or both modified approaches (which we refer to as LIST and QUICK methods respectively) for each cell graded. The LIST method provides partial credit and customized feedback and includes enhancements to the approach of Matthews et al. (2013) to improve grading speed. When speed of grading is a primary objective, the instructor can employ the QUICK method solely, foregoing partial credit and customized feedback. Setup time for the grading of new assignments is relatively modest. The automated grader is available from the author as an Excel add-in.

To evaluate efficacy of the auto-grader, we compare manual and auto-grading results for a sample of exams originally graded by hand. The results show that the average exam scores for the two grading methods statistically differ but not materially (a difference of 3.40 points on a 100 point scale). Examination of

the difference in scoring at the individual question level for a randomly selected subsample provides evidence that the autograder scores more accurately than manual scoring. Speed of grading is evaluated by re-grading the sample of student files using the grading program's QUICK method. Average computer grading time per student file is 6.2 seconds.

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