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A Simultaneous Equation Approach to Financial Planning Using Cash Flow Components

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ABSTRACT

The underlying thesis of this paper is that financial planning models would be enhanced substantively if the interaction effects among the several variables were measured and incorporated into the planning process. A three-stage least squares (3SLS) technique was used to recognize the simultaneous interdependencies among the relative cash flow components. The study found the signs and significance of the estimated coefficients generated by ordinary least squares (OLS) and 3SLS methods were quite different from each other. Furthermore, there was a marked improvement in the performance of the 3SLS model when the variables associated with the relative free cash flow after working capital (FCF*) were used. Finally, the introduction of more interdependencies among the several cash flow variables resulted in improving the performance of the simultaneous equation approach. In conclusion, the study found the analysis of the financial planning models is enhanced by incorporating the interdependencies among the key financial planning variables.

A SIMULTANEOUS EQUATION APPROACH TO FINANCIAL PLANNING USING CASH FLOW COMPONENTS

In the 1960s and 1970s several financial planning models were developed to simulate the decision making process and environment in which corporate managers developed forecasting scenarios of long-run financial plans, e.g., Carleton [3], Francis and Rowell [4], Gentry and Phyrr [10], Gershefski [11], Ijiri, Levy and Lyon [14], Mattessich [15], Myers and Pogue [17], Pindyck and Rubinfeld [18] and Warren and Shelton [21]. In general these models were based on economic principles and generated financial statements that simulated a variety of corporate strategies. The simulated data were used to evaluate the effect of various financial planning strategies on the estimated value of a firm.

The financial planning models of Francis and Rowell (FR) and Warren and Shelton (WS) were identified as being simultaneous, but in a mathematical sense they were built on a series of recursive equations. They used stock and flow variables in a variety of econometric techniques to estimate key relationships. FR and WS developed several separate financial planning sectors, e.g., generating sales and operating earnings, discovering the amount of capital and total assets needed, determining the financing required to meet the forecasted level of assets, and solving for the known interdependencies within each sector. The simultaneous interdependencies that existed among the various sectors were not developed explicitly, but rather FR and WS built their models on a series of recursive equations that brought the separate planning sectors together. Therefore, a primary objective of this paper is to capture the simultaneous interdependencies that exist among the several financial planning sectors.

Model building in the 1980s changed from estimating financial statements with several variables in a static and deterministic setting to utilizing stochastic cash flow variables that change over time. Also in the 1980s two types of valuation models emerged that integrated short-run financial management variables into long-run financial planning models. These modified valuation models were based on cash flow information. Morris [16] introduced the use of cash inflows and outflows in a single period CAPM valuation framework. The Morris model is based on the idea that operating cash flow shortfalls must be financed either from existing cash balances or with costly borrowing. If borrowing is used, it increases the systematic risk of the dividends being paid at the end of the operating horizon. The Morris framework highlights the idea that managing cash flows is a primary activity of a firm and that critical resources are invested in cash and receivables as well as in capital assets and inventories.

Sartoris and Hill (SH) [20] and Gentry and Lee (GL) [7] have integrated short-run cash inflows and outflows into a net present value (NPV) model. Traditionally investment and financing activities provide the basic inputs for valuation models. However SH and GL incorporated all cash inflows and outflows related to operations into an expanded and more integrated valuation model. The result is that the causes of changes in value can be more easily identified and interpreted on either an <u>ex post</u> or <u>ex ante</u> basis. In a longer-run perspective, Rappaport [19] uses selected cash flow information in an NPV model to solve for the value of a firm.

These cash model builders--WS, FR, Morris, SH and GL--recognized the need to integrate the divergent pieces of cash flow information. However, they did not take into account the interaction effects that exist among the numerous variables. Rather, for ease of computation they used a recursive approach to generate pro forma financial statements.

Recently, two events have occurred that make it possible to develop a system that takes into account the joint interaction effects among the several financial planning variables. One development was the relative ease of computing a three stage least squares (SLS) statistical model. A 3SLS model is an advanced statistical technique that allows the measurement and interpretation of joint interaction effects among a set of interrelated financial planning variables. The 3SLS technique provides the anchor for the simultaneous financial planning model presented in this paper. A second event is the development of a cash flow model that measures the relative contribution of 12 cash flow components to a firm's total cash inflows or outflows. The relative cash flow measures have been used successfully in a probit statistical model and an expert system with inductive learning to predict financial failure, bond ratings and loan risk ratings. The relative cash flow measures are the basic information used in the 3SLS model that determines a simultaneous cash flow valuation model. Our thesis is that a financial planning model would be enhanced if the interaction effects among the several variables were explicitly measured and interpreted. A three stage least squares analysis is used to measure and interpret the simultaneous interdependence of cash flow components as they relate to a firm's free cash flow.

Section II briefly reviews the relative cash flow model and the concept of free cash flow used in this paper. The simultaneous model used to explain the interaction effects among the relative cash flow components is developed in Section III. The sample used in the analysis is found in Section IV and the analysis follows in Section V. In the last section the conclusions are presented.

II. CASH FLOW MODEL

After extensive use of the Helfert [12] funds flow analysis statement, Gentry, Newbold, and Whitford [8,9] restructured and refined it into 12 major cash flow components. The cash flow statement is based on information from the income statement and changes in balance sheet items between two periods. This integrated financial statement provides cash flow information for measuring and judging the overall effectiveness of management.

The 12 absolute cash flow components are operating (NOF), Δreceivables (ΔARF), Δinventories (ΔINVF), Δother current assets (ΔOCAF), Δpayables (ΔAPF), Δother current liabilities (ΔOCLF), Δfinancial (ΔNFF), fixed coverage expenditures (FCE), investment (NIF), dividends (DIV), Δother asset and liability flows (ΔNOA&L), and Δcash and marketable securities (ΔCash). A net flow is determined for four of the components, namely operating, Δother assets and liabilities, Δfinancing, and investment. A cash inflow has a positive sign and a payment has a negative sign. The algebraic sum of the components are equal to the change in cash and marketable securities.

Relative cash flow components represent the percentage contribution each cash flow component makes to the total cash flow. The percentage contribution of each relative component is based on the concept that the sum of the inflows equals the sum of the outflows. The relative cash flow component is calculated by dividing each component by the total cash flow (TCF), which is equal to either the total inflow (TI) or the absolute value of total outflow (TO). The relative cash flow components are identified with an asterisk and they are presented in equation (1).

$$NOF_t^* + \Delta ARF_t^* + \Delta INVF_t^* + \Delta OCAF_t^* + \Delta APF_t^* + \Delta OCLF_t^* + \Delta NFF_t^* + FCE_t^* + NIF_t^* + DIV_t^* + \Delta NOA\&L_t^* - \Delta Cash_t^* = 0 \quad (1)$$

An example of the hierarchy of the relative cash flow components (CFC*) and the relative free cash flow components (FCF*) is presented in Exhibit 1. Exhibit 1 shows Company A has 100 percent of its cash inflows originate from operations. After subtracting the basic outflows for capital investment (40%), dividends (10%), fixed coverage expenditures (5%) and working capital (10%), the FCF* from operations after working capital is 35 percent. In contrast Company D has 25 percent of its cash inflow coming from operations. After deducting the cash outflows for investment (20%), fixed coverage expenditures (30%), Company D has a FCF* after working capital of a -25 percent.

Exhibit 1 illustrates several basic concepts related to FCF* and risk. First, as the percentage of cash inflows coming from net operations declines, there is a decline in FCF* after working capital. Second, as the FCF* after working capital declines, the riskiness of the firm increases. The example shows the higher the FCF* after working capital the lower the risk. Third, as the relative cash inflow from operations (NOF*) decreases from Company A to Company D, the relative cash outflow to investment (NIF*) decreases and the relative cash outflow for fixed coverage expenditures (FCE*) increases. In each of these scenarios there is an increase in risk.

Why is the relative free cash flow after working capital (FCF*) considered to be a significant cash flow measure? First, FCF* is determined after taking into account critical operating cash flow components, i.e., NOF*, ΔARF*, ΔINVF*, ΔOCAF*, ΔAPF*, and ΔOCLF, plus strategic and discretionary cash flow components, i.e., NIF*, DIV*, and FCE*. Generally, these nine components capture the preponderance of a firm's cash inflows and outflows. Second, the remaining cash flow components frequently represent a relatively small proportion of the total cash flow components. If the NOF* is relatively small, such as Firms C and D in Exhibit 1, the shortfall in FCF* is made up by either increasing ΔNFF* or reducing the ΔCash*. If NOF* is relatively high, more than likely the excess FCF* will be used to replace components in the ΔNFF* or it is invested in marketable securities, ΔCash. Finally, the ΔNOA&L* represent the net change in accrued assets and liabilities, which can be either an inflow or an outflow.

It is hypothesized that FCF* and ΔFCF* over time provide a unique cash flow measure for interpreting the cause for a ΔNFF* or ΔCash.

III. A SIMULTANEOUS EQUATION MODEL

The example in Exhibit 1 indicates the higher the FCF* measure, the lower the risk. In a present value context, the value of a firm is positively related to its FCF* measure. The following simultaneous model is based on the level of FCF* and the variables that precede the FCF*. As indicated the three stage least squares technique allows for a joint simultaneous interaction effect among the variables.

The contribution of the joint simultaneous interaction effect to a financial planning model is highlighted by comparing the three stage least squares approach to the percentage of sales method. In the percentage of sales forecast method the estimated percentage change in sales is used to determine the percentage change in each asset and each spontaneous liability and the funds needed for the next fiscal period. Because sales drive the change in assets and spontaneous liabilities and there is no feedback from each asset or the spontaneous liabilities to sales. Nor is there any interaction among the assets and the spontaneous liabilities. The percentage of sales method is an example of a one way interaction effect. In contrast the three stage least squares method takes into account all of the joint simultaneous interaction effects that exist among sales, assets and spontaneous liabilities. In essence, the three stage least squares model is a more comprehensive model that captures the interaction effects among all of the cash flow components.

To understand how the simultaneous equation model operates let us turn to the relationship between accounts receivable and sales. The percentage sales method represents a one-way relationship, while more than likely there exists a natural ongoing feedback system between receivables and sales. Exhibit 2 helps to illustrate the feedback system by presenting nine scenarios that capture the behavior of receivables vis-a-vis changes in sales. For example, in Cell 3 an increase in sales results in a comparable increase in receivables. Thus, a change in receivables is the result of a sales effect. However, in Cell 4 receivables increase more rapidly than sales. Clearly a sales effect causes a portion of the increase, but a collection effect also comes into play. That is, as sales were increasing, management allowed the customers to slow down their payments, which may be related to the bargaining power that exists between the seller and the buyer. Furthermore, the slow down in collection may cause customers to increase their rate of purchases, which results in sales increasing more rapidly than they otherwise would have.

In contrast, Cell 7 shows receivables not increasing as rapidly as sales because management decided to tighten collection procedures, which may be related to the bargaining power between the seller and the buyers. The feedback system may cause customers to purchase at a slower rate, which may create a dampening effect on sales and prevent them from increasing at a higher rate. These two examples highlight the complex two-way feedback system that may exist between sales and receivables. A comparable simultaneous feedback story could be created for each of the remaining cells in Exhibit 2. The feedback system between NOF* and ΔARF* is crystallized by recalling that sales are the primary inflow component of net operating cash flow (NOF*).

Similarly, there is an interdependence between production and inventory that is also portrayed in Exhibit 2. Cell 3 portrays inventory increasing at the same rate as production costs, which reflects a production cost effect. Cell 4 in Exhibit 2 shows inventory increasing more rapidly than production costs. This increase in inventory can be associated with a decrease in inventory control. Additionally, the decrease in inventory control may cause production costs to increase more rapidly than they otherwise would have. In contrast, Cell 7 shows inventory not increasing as rapidly as production costs. In this example it is hypothesized that tighter inventory controls were established which may result in production costs being lower than they would have been otherwise. Exhibit 2 helps to focus on a feedback mechanism that more than likely exists between production and inventory.

A brief review of the several interrelationships that exist in Exhibit 2 helps solidify the depth of the feedback system. Production costs are the major cash outflow component in net operating flows (NOF*), and ΔARF* and ΔINVF* are interrelated to NOF*. In a cash flow perspective the operating cycle depicts the natural relationship that exists between ΔARF* and ΔINVF*. The operating cycle assumes that cash is needed to finance a build-up in either raw material, goods-in-process, or finished goods. If credit terms are involved in the sale, the finished goods inventory is reduced when the goods are delivered and, in turn, there is an immediate build-up in receivables.

The operating cycle is complete when the customer pays for the goods. In a recession there may be a build-up in any of the inventory components because of a decline in demand. Likewise, as demand falls, unless there is a substantive change in the collection effect, receivables will decline. In a period of rapid growth there can be a shortage of inventory, but an increase in sales and receivables. Thus, under most conditions in the operating cycle, receivables and inventory are negatively related. In addition, more than likely there is a feedback system between ΔARF* and ΔINVF*. That is, a decline in ΔARF* is signalling to the inventory control management the need to produce less and, therefore, reduce raw material and goods in process. Alternatively, a large relatively rapid increase in ΔINVF* signals to credit management a slowdown in demand and a need to tighten or at least maintain the same collection performance.

We have just demonstrated the interrelationships and the feedback system that exists among NOF*, ΔARF*, and ΔINVF*. Additionally, it is plausible to hypothesize the existence of a simultaneous feedback system among all of the cash flow components. The following is an attempt to identify a simple, but plausible simultaneous equation model that depicts a feedback mechanism among key cash flow components. The model uses all of the cash flow components that are included in the FCF* after working capital approach.

$$NOF^* = f_1(\Delta AR^*, \Delta INVF^*, \Delta APF^*, FCE^*, DIV^*, \Delta OCLF^*) \qquad (2)$$

$$\Delta ARF^* = f_2(\Delta APF^*, NOF^*) \qquad (3)$$

$$\Delta INVF^* = f_3(\Delta APF^*,\ FCE^*,\ NOF^*,\ FCF^* \text{ or } \Delta Cash^*) \quad (4)$$

$$\Delta APF^* = f_4(\Delta ARF^*,\ NOF^*,\ \Delta INVF^*,\ FCE^*,\ FCF^* \text{ or } \Delta Cash^*) \quad (5)$$

$$NIF^* = f_5(NOF^*,\ FCE^*,\ FCF^* \text{ or } \Delta Cash^*) \quad (6)$$

and

$$\text{IDENTITY } FCF^* = \Delta Cash - \Delta NFF^* - \Delta NOA\&L^* \quad (7)$$

where the identity ΔCash was reported in equation 1.

IV. DATA SAMPLE

It was decided to test the simultaneous equation model in a recession period, 1983, and in a nonrecession period, 1987. To accomplish the test it was necessary to calculate the 12 cash flow components for a large sample of companies. To be included in the sample a company had to have its fiscal year end in December and to have complete balance sheet and income statement data for 1982 and 1983 and for 1986 and 1987. A sample of 117 companies were selected from the annual Compustat Industrial File.

V. ANALYSIS

The analysis uses cash flow components to compare the performance results of a traditional unidirectional (OLS) financial planning model to a simultaneous interactive feedback model (3SLS). Also the analysis compares the results of using free cash flow after working capital (FCF*) to the free cash flow before the change in cash (CC*). Finally, to determine if economic conditions affect the cash flow relationship, the results for a recessionary period, 1983, are compared to a period of expansion or nonrecession, 1987.

One approach to financial planning and forecasting is the percentage of sales method. In that method it is postulated that receivables (AR), inventories (INV), and the other asset accounts, plus accounts payable (AP) respond spontaneously to a change in sales. Additionally, it is assumed that the ratio between the independent and dependent variables remains the same. In terms of the regression equation, for example, this means regressing sales against AR, AP, or INV without intercepts. However, it is widely known that such a fixed proportion relationship does not hold for any prolonged time period. A realistic version would allow for changes in the proportion which means regressing with intercepts. This happens by allowing other variables to influence the dependent variable in a generalized version of percentage of sales method. Specifically, the task is to estimate Equations (2) through (6) by using an Ordinary Least Squares (OLS) multiple regression with intercepts.

After duplicating the percentage of sales financial planning method, a simultaneous equation model using the 3SLS estimation technique is introduced. The simultaneous equation model estimates each of the above equations by incorporating an interaction effect. Specifically, when ΔARF* is regressed against NOF* in Equation (2) using the OLS method, the analysis focuses only on the unidirectional relationship where NOF* is influencing ΔARF* and not vice versa. However, when estimating Equation (2) with the 3SLS method, the feedback from Equation (2) is incorporated. Thus, ΔARF* is not only determined by NOF*, it, in turn, helps determine NOF*. The above model uses two versions of free cash flow information--free cash flow after net working capital, which is called FCF*, and the other is free cash flow before the change in cash, CC* version. The CC* version takes into account all variables in FCF* plus ΔNFF* and ΔOA&LF*. These two experiments were used to determine if there is a difference in the explanatory power of the two free cash flow measures. Estimates of the above models are completed for the two separate years, 1983 and 1987.

For each equation there are four estimates using the OLS method and four estimates using the 3SLS method. For example, the following estimates of NOF* are generated: OLS and 3SLS estimates using the FCF* approach and the CC* approach for 1983, and OLS and 3SLS estimates using the FCF* approach and the CC* approach for 1987.

In reporting the results for each variable, the data are presented in the exhibits in the above order. Furthermore, to evaluate if the economic conditions affect the cash flow relationships, the results for each year are presented in separate exhibits.

Equation (2)

The analysis begins with NOF* as the dependent variable as shown in Equation (2). Only the results of the significant OLS and 3SLS estimates are reported in the several exhibits. That is, all the variables in Equation (2) were included in the OLS regression and the 3SLS method initially, but only the significant variables are reported in the exhibits. Specifically, the FCF* version in Exhibit 3 shows that only ΔARF*, DIV*, and ΔOCLF* were significant in the OLS approach. Additionally, the OLS coefficients in Exhibit 3 show that

NOF* is positively related to ΔARF*, DIV* and ΔOCLF*. A brief explanation is needed for the relationship between NOF* and ΔARF*. Empirically, as NOF* increases the ΔARF* also increases, or vice versa. That is, in a cash flow context, when accounts receivables are increasing, a use of cash, they are accommodating the expansion in sales and NOF*. Also, the negative sign associated with the DIV* coefficient indicates DIV*, a use of cash, increased as NOF* increases or vice versa.

In contrast the 3SLS estimates reported in the FCF* version of Exhibit 3 indicate that NOF* is negatively related to ΔARF*. This finding appears to be counterintuitive. However, by using an interactive feedback system approach the results can be meaningfully explained. In a period of economic recession management is concerned that the collection period will increase, therefore, collection procedures are frequently tightened and under severe conditions credit may not be extended to high risk accounts. The result of the restrictive decision is to cause the change in receivables to decline and perhaps the rate of change will be lower than the change in sales, which is demonstrated in Cells 7, 2' and 5 in Exhibit 2. This brief discussion shows that the unidirectional OLS regression provides an interpretation that is opposite the interactive feedback approach provided by the 3SLS method. Further, the 3SLS uncovers subtle nuances and provides a more in-depth interpretation of the total interaction effects among the variables.

The ΔAPF* provides another substantive difference between the results generated by the OLS and 3SLS. The FCF* version in Exhibit 3 shows the ΔAPF* is significant at the .01 level of significance for the 3SLS method, but it is not significant for the OLS regression. The 3SLS finding indicates that in a recession accounts payable are an important source of cash in financing the operations of industrial companies. The OLS results did not detect this relationship.

Turning to the interpretation of the OLS and 3SLS coefficients in 1987, which are found in the FCF* version of Exhibit 4, several important observations emerge. First, the OLS coefficient for the ΔARF* is not statistically significant, but the 3SLS coefficient shows it is significant at the .01 level. The 3SLS coefficient indicates the ΔARF* is also a source of cash in a period of economic expansion. This finding indicates that in 1987 there was a substantive collection effort to prevent receivables from growing more rapidly than sales and NOF*. Second, ΔAPF* is significant at the .0153 level of significance for the 3SLS method, but it is not a significant source of cash in the OLS method. Third, the outflow of cash to interest and leasing expenses (FCE*) is significant at the .01 level of significance for the 3SLS method, but it was not significant in the 1983 recessionary period. The FCE* finding indicates there is a marked increase in the use of debt in a period of expansion and that it is evident across a broad cross-section of industrial companies.

When the FCF* version was compared to the CC* version, there was a clear improvement in performance of the simultaneous equation model. The weighted R^2 provides a measure for comparing the performance of the two versions of the simultaneous equation model. Exhibit 3 shows the weighted R^2 for the FCF* version is .46 compared to .36 for the CC* version. In 1987, the performance of the FCF* version is markedly better than the CC* version. Exhibit 4 shows the weighted R^2 for the FCF* version is .51 and .18 for the CC* version. Furthermore, for each of the remaining variables to be analyzed, the FCF* version shows a clear improvement. For the OLS estimates, only the equation with FCF* improved without changing the performance of the other equations. However, the FCF* version in the simultaneous equation model improved the performance of each equation in the system which is shown by the weighted R^2. Further, the significance of the other related variables improved. The preceding analysis shows that it is important to use theoretically more meaningful variables, which is the FCF* after working capital.

The analysis related to Equation (2) suggests several dimensions. First, using FCF* in a 3SLS model provides a richer and more insightful interpretation for financial planning purposes. Second, the FCF* version of the cash flow information provides significantly better results for financial planning. Third, in the 3SLS model the variables that were significant in 1983 were also significant in 1987 and the signs of the coefficients were the same for both time periods. For financial planning purposes the relative free cash flow variables that were found to be of most importance in both years were the change in accounts receivable (ΔARF*), the change in accounts payable (ΔAPF*), and dividends (DIV*). Finally, the statistical significance of the FCE* component in 1987 had the wrong sign, but in 1983 it was insignificant for both OLS and 3SLS.

Equation (3)

When ΔARF* is the dependent variable, the OLS and the 3SLS models in Exhibits 5 and 6 show both FCF* variables, ΔAPF* and NOF*, are significant at the .01 level of significance. As in Equation (2), the OLS relationship between ΔARF* and NOF* is reversed in the 3SLS model. That is, in 3SLS as NOF* increases, accounts receivable are declining which indicate an increase in the collection effort and a more efficient operation. Also, there is a positive relationship between ΔAPF* and ΔARF* for both OLS and 3SLS which indicates as receivables increase, the accounts payable are also increasing, and vice versa. Exhibits 5 and 6 show the same pattern for the two independent variables which suggests the relationships are stable and unchanged between 1983 and 1987. The weighted R^2 is higher for the FCF* version in both years, as shown in Exhibits 5 and 6.

Equation (4)

In Equation (4) the ΔINVF* is the dependent variable. The 3SLS approach shows a significant negative relationship between ΔAPF* and ΔINVF*. Exhibits 7 and 8 show the OLS coefficients for the four independent FCF* variables--ΔAPF*, FCE*, FCF*, and NOF*--were statistically significant in both years. However, Exhibits 7 and 8 show the 3SLS analysis found FCF* after working capital was not significant, but the remaining three independent variables were significant at the .01 level of confidence. The analysis shows a negative relationship between ΔAPF* and ΔINVF* which means as payables increase there is an increase in inventory and vice versa. Also, 3SLS indicates an increase in FCE* as associated with a decrease in ΔINVF* or vice versa. Furthermore, the 3SLS shows an increase in NOF* is associated with a decrease in inventory (ΔINVF*) or vice versa, which is opposite the OLS interpretation.

The preceding observations are similar to the relationship observed between ΔARF* and NOF*. The feedback interpretation is that as net operating cash flows increase, companies are more efficient in the management of inventory and receivables. It also means when NOF* is declining, the companies are less efficient in managing inventories and receivables. This 3SLS finding is contrary to the popular belief of a positive relationship among NOF* and ΔINVF* and ΔARF*. The results are the same in 1983 and 1987, as reported in Exhibits 7 and 8. Finally, the weighted R^2 is markedly higher for the FCF* version of the model in both years.

Equation (5)

Equation (5) focuses on ΔAPF* as the dependent variable. The results of the OLS and 3SLS analyses are presented in Exhibits 9 and 10. When using the FCF* version in the 1983 OLS regression, all but one of the independent variables are statistically significant at the .01 level of confidence, but using the 3SLS method only ΔINVF* is significant at the .0569 level of significance. The 1987 data found ΔINVF* and NOF* were significant at the .01 level when using 3SLS, while the OLS regression shows ΔARF*, ΔINVF* and NOF* as significant. These 3SLS findings are consistent with the 3SLS coefficients associated with the ΔARF* and ΔINVF*.

As in the previous tests, various specifications used both OLS and 3SLS methods. In general, the results show that introducing more interdependencies improves the performance of the simultaneous equation model in terms of a weighted R^2, as shown in Exhibit 10. A brief review of the decision process associated with Exhibit 10 will assist in the interpretation of the weighted R^2 results. Originally, only NOF* was significant. However, by dropping the insignificant variables, initially ΔARF* and FCF*, in sequence, the results showed that either ΔINVF* or FCE*, not both in the same equation, become significant. When choosing to retain ΔINVF* and drop FCE*, the system performance improved. Opting for ΔINVF*, an endogenous variable, introduces more interdependencies in the system. Whereas opting for FCE*, which is the exogenous variable in the model, instead of ΔINVF* reduces the model reliability. The entire discussion indicates the FCF* data are better explained with the interdependent system.

The above result suggests that we need to use simultaneous equation model to explain cash flow components. Further, our effort should be focused in discovering theoretically meaningful variables. In that way we will have a richer interdependent model.

Equation (6)

In Equation (6) the cash flow for net investment (NIF*) is the dependent variable and the statistical results are reported in Exhibits 11 and 12. The purpose is to determine which variables explain the behavior of NIF* when the OLS regression uses 1983 FCF* variables, all three--NOF*, FCE*, and FCF*--are statistically significant. However, the 3SLS identifies NOF* and FCF* as having a significant effect on NIF*, but it finds FCE* is not significantly related to net investment. This means that NIF* increases as NOF* increases or vice versa. Additionally, NIF* is inversely related to FCF*, that is, both technically and intuitively, when FCF* is increasing NIF* is decreasing or vice versa. The results for the 1987 data are similar to the 1983 finding with one exception. The FCE* is not significant in the OLS regression in 1987. The weighted R^2 for the FCF* version are greater than the R^2 for the CC* version for both years.

VI. CONCLUSIONS

A primary objective of this paper was to discover the simultaneous interdependencies that exist among the several cash flow components involved in financial planning. A three-stage least squares method was used to interpret the simultaneous interaction among the several components of free cash flow after working capital. The analysis of the cash flow information generated three distinct conclusions.

First, the signs and statistical significance of the estimated coefficients generated by the OLS and 3SLS methods were highly sensitive to the technique used. In several cases the interpretation provided by OLS, the traditional financial planning technique, was reversed by using a simultaneous equation model. From a financial planning perspective, the 3SLS results highlighted the importance of using a system that incorporates feedback among the cash flow components. Thus, it is important in financial planning to search for the optimal technique that utilizes an interactive feedback system among the cash flow variables.

Second, there was a substantive improvement in the performance of the simultaneous equation model when the relative free cash flow (FCF*) variables were used vis-a-vis the relative change in cash (CC*) approach. In the single equation model only the equation with FCF* improved in explanatory power while the other equations remained unaffected. Furthermore, the signs and statistical significance of the 3SLS estimated coefficients were sensitive to the specific free cash flow variable used in the analysis.

Finally, the introduction of more interdependencies among the several cash flow variables resulted in improving the simultaneous equation models. The study has discussed and illustrated the power of the analysis is enhanced substantively by incorporating interdependence in financial planning models. The simultaneous equation models provide subtle insights and nuances that exist among the cash flow components and should be incorporated in the financial planning process.

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Exhibit 1

AN EXAMPLE OF THE HIERARCHY OF RELATIVE CASH FLOW COMPONENTS
AND RELATIVE FREE CASH FLOW (FCF*) MEASURES
UNDER VARIOUS RISK CONDITIONS

	Company			
	Lowest Risk			Highest Risk
Relative Cash Flow Measures	A	B	C	D
Net Operating (NOF*)	100%	75%	50%	25%
Net Investment (NIF*)	-40	-35	-30	-20
	60	40	20	5
Dividends (DIV*)	-10	-15	-20	0
Fixed Coverage Exp. (FCE*)	- 5	-10	-15	-30
FCF* Before Working Capital	45	15	-15	-25
ΔNet Working Capital (ΔNWC*)[1]	-10	- 8	- 5	0
FCF* After Working Capital	35%	7%	-20%	-25%
ΔNet Financing (ΔNFF)	—	—	—	—
ΔNet Other A & L (ΔNOA&L)	—	—	—	—
ΔCash & M.S. (ΔCash)	—	—	—	—
FCF* After All Cash Flows	0	0	0	0

[1] ΔNWC* = ΔARF* + ΔINVF* + ΔOCA* + ΔAP* + ΔOCL*

Exhibit 2

Examples of Relationships that Cause Changes in Payables and Receivables

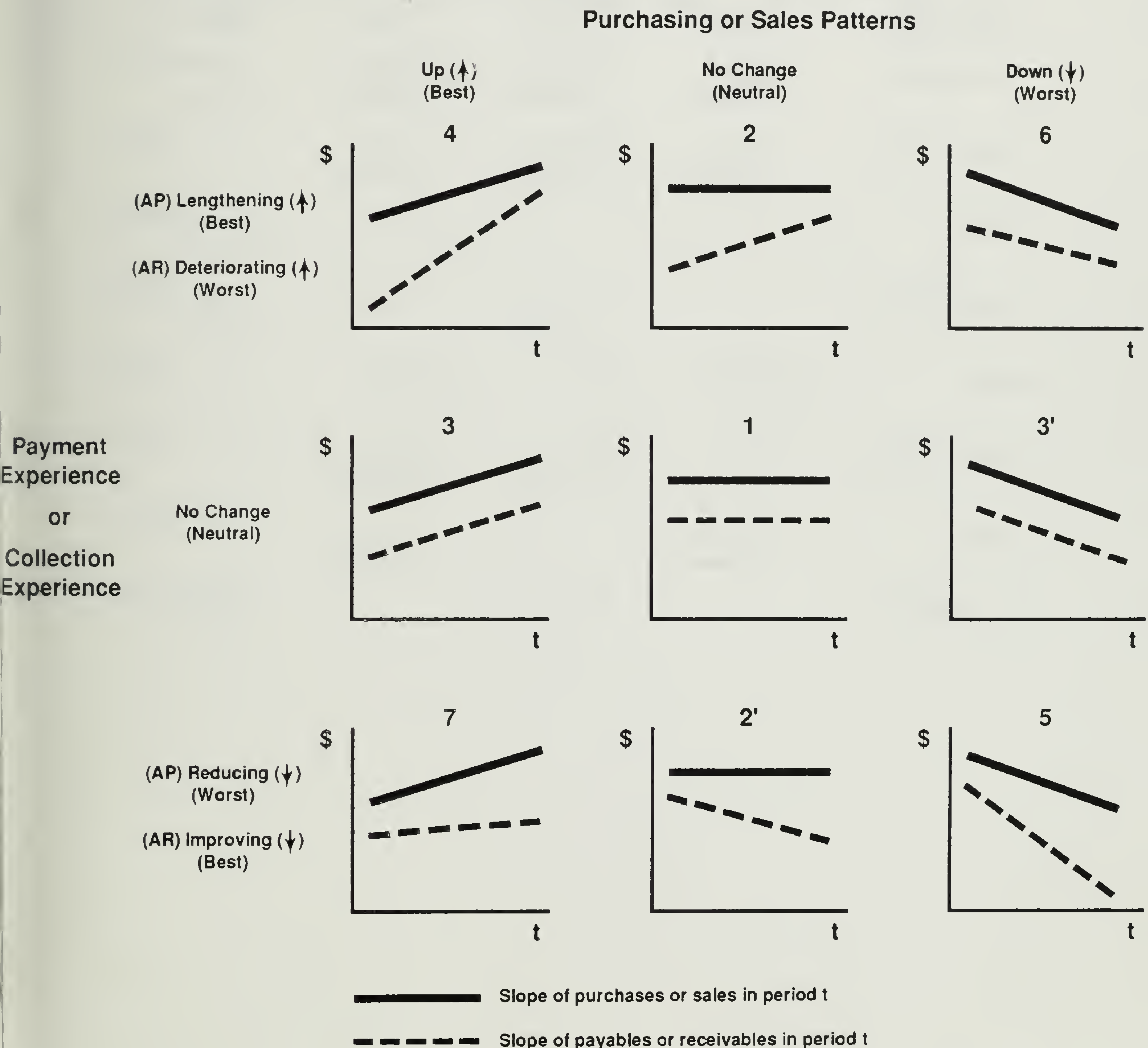

Exhibit 3

COEFFICIENTS FOR OLS AND 3SLS WITH NOF*
AS THE DEPENDENT VARIABLE, 1983

Independent Variables	FCF* Version OLS	FCF* Version 3SLS	CC* Version OLS	CC* Version 3SLS
Intercept	0.48 (0.0001)	0.34 (0.0001)	0.48 (0.0001)	0.35 (0.0001)
ΔARF*	-0.27 (0.0095)	0.75 (0.0001)	-0.27 (0.0095)	*
ΔINVF*	*	*	*	2.40 (0.0001)
ΔAPF*	*	5.60 (0.0001)	*	5.64 (0.0001)
FCE*	*	*	*	*
DIV*	-1.16 (0.0001)	-1.02 (0.0001)	-1.16 (0.0001)	*
ΔOCLF*	0.33 (0.0466)	*	0.33 (0.0466)	*
Weighted R^2		0.46		0.36

Exhibit 4

COEFFICIENTS FOR OLS AND 3SLS WITH NOF*
AS THE DEPENDENT VARIABLE, 1987

Independent Variables	FCF* Version OLS	FCF* Version 3SLS	CC* Version OLS	CC* Version 3SLS
Intercept	0.39 (0.0001)	0.52 (0.0001)	0.39 (0.0001)	0.51 (0.0001)
ΔARF*	*	2.05 (0.0001)	*	1.57 (0.0001)
ΔINVF*	*	*	*	*
ΔAPF*	*	2.31 (0.0153)	*	2.64 (0.0025)
FCE*	-0.52 (0.0232)	-0.49 (0.0165)	-0.52 (0.0232)	*
DIV*	-1.33 (0.0001)	-1.12 (0.0001)	-1.33	-0.97 (0.0001)
ΔOCLF*	*	*	*	*
Weighted R^2		0.51		0.18

Exhibit 5

COEFFICIENTS FOR OLS AND 3SLS WITH ΔARF*
AS THE DEPENDENT VARIABLE, 1983

Independent Variables	FCF* Version OLS	FCF* Version 3SLS	CC* Version OLS	CC* Version 3SLS
Intercept	0.14 (0.0108)	*	0.14 (0.0108)	*
ΔAPF*	-0.63 (0.0001)	-5.59 (0.0001)	-0.63 (0.0001)	-3.04 (.00001)
NOF*	-0.28 (0.0003)	0.23 (0.0047)	-0.28 (0.0003)	0.16 (0.0164)
Weighted R^2		0.46		0.36

Exhibit 6

COEFFICIENTS FOR OLS AND 3SLS WITH ΔARF*
AS THE DEPENDENT VARIABLE, 1987

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	-0.20 (0.0028)	-0.08	*
ΔAPF*	-0.50 (0.0004)	-1.16 (0.0218)	-0.48 (0.0009)	-1.92 (0.0001)
NOF*	-.13 (0.0004)	0.25 (0.0081)	*	*
Weighted R^2		0.51		0.18

Exhibit 7

COEFFICIENTS FOR OLS AND 3SLS WITH ΔINVF*
AS THE DEPENDENT VARIABLE, 1983

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	-0.34 (0.0001)	*	*
ΔAPF*	-0.58 (0.0001)	-3.12 (0.0001)	-0.68 (0.0001)	-2.47 (0.0001)
FCE*	-0.42 (0.0013)	-0.47 (0.0001)	-0.38 (0.0075)	*
FCF*/ΔCash*	0.26 (0.0001)	*	-0.26 (0.0009)	-0.16 (0.0531)
NOF*	-0.10 (0.0056)	0.52 (0.0001)	-0.07 (0.0543)	0.22 (0.0001)
Weighted R^2		0.46		0.36

Exhibit 8

COEFFICIENTS FOR OLS AND 3SLS WITH ΔINVF*
AS THE DEPENDENT VARIABLE, 1987

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	-0.14 (0.0086)	*	-0.05 (0.0583)
ΔAPF*	-0.40 (0.0003)	-1.14 (0.0071)	-0.46 (0.0001)	-0.66 (0.0172)
FCE*	-0.41 (0.0003)	-0.28 (0.0166)	-0.32 (0.0131)	*
FCF*/ΔCash*	0.20 (0.0001)	*	*	*
NOF*	-0.11 (0.0001)	0.23 (0.0041)	*	0.09 (0.0336)
Weighted R^2		0.51		0.18

Exhibit 9

COEFFICIENTS FOR OLS AND 3SLS WITH ΔAPF*
AS THE DEPENDENT VARIABLE, 1983

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	*	*	*
ΔARF*	-0.22 (0.0001)	*	-0.20 (0.0001)	-0.19 (0.0001)
ΔINVF*	-0.30 (0.0001)	-0.21 (0.0569)	-0.27 (0.0001)	-0.21 (0.0001)
FCE*	-0.20 (0.0010)	*	-0.20 (0.0011)	*
FCF*/ΔCash*	0.08 (0.0042)	*	-0.10 (0.0207)	*
NOF*	*	*	*	0.07 (0.0001)
Weighted R^2		0.46		0.36

Exhibit 10

COEFFICIENTS FOR OLS AND 3SLS WITH ΔAPF*
AS THE DEPENDENT VARIABLE, 1987

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	*	*	*
ΔARF*	-0.15 (0.0146)	*	-0.13 (0.025)	-0.65 (0.0001)
ΔINVF*	-0.20 (0.0062)	-0.39 (0.0014)	-0.19 (0.0070)	-0.36 (0.0001)
FCE*	*	*	*	*
FCF*/ΔCash*	*	*	*	*
NOF*	0.04 (0.0041)	0.06 (0.0001)	*	*
Weighted R^2		0.51		0.18

Exhibit 11

COEFFICIENTS FOR OLS AND 3SLS WITH NIF*
AS THE DEPENDENT VARIABLE, 1983

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	-0.15 (0.0083)	*	-0.31 (0.0001)	*
NOF*	-0.40 (0.0001)	-0.54 (0.0001)	-0.20 (0.0105)	-0.48 (0.0001)
FCE*	-0.29 (0.0517)	*	-0.45 (0.0174)	*
FCF*/ΔCash*	0.45 (0.0001)	0.58 (0.0001)	-0.38 (0.0001)	*
Weighted R^2		0.46		0.36

Exhibit 12

COEFFICIENTS FOR OLS AND 3SLS WITH NIF*
AS THE DEPENDENT VARIABLE, 1987

Independent Variables	FCF* Version		CC* Version	
	OLS	3SLS	OLS	3SLS
Intercept	*	*	-0.17 (0.0003)	*
NOF*	-0.50 (0.0001)	-0.50 (0.0001)	-0.23 (0.0022)	-0.39 (0.0001)
FCE*	*	*	*	*
FCF*/ΔCash*	0.43 (0.0001)	0.53 (0.0001)	*	0.99
Weighted R^2		0.51		0.18

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